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ABSTRACT

Each year since 1969, National Assessment has gathered information about levels of achievement. This report summarizes the National Assessment study of changes in science achievement for 9-year-olds, 13-year-olds, and 17-year-olds attending schools. Having assessed achievements in science twice, National Assessment can report information on the progress or decline of knowledge in science. Highlights of the study indicate that knowledge of fundamental scientific facts and principles as measured by National Assessment declined among American students between 1969 and 1973. Other data indicate the gap between students in the Southeast and other parts of the nation narrowed between 1969 and 1973. Performance of boys continued to exceed those of girls. Performance of white students also continued to exceed those of blacks. Numerous tables and figures are used to present data. (RH)

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SCIENCE TECHNICAL REPORT: SUMMARY VOLUME

SE 022 646

NATIONAL ASSESSMENT OF EDUCATIONAL PROGRESS
A Project of the Education Commission of the States

Jerry Apodaca, Governor of New Mexico, Chairman, Education Commission of the States
Warren G. Hill, Executive Director, Education Commission of the States
Roy H. Forbes, Director, National Assessment

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SCIENCE TECHNICAL REPORT: SUMMARY VOLUME

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FOREWORD

The National Assessment of Educational Progress (NAEP) is an information-gathering project that surveys the educational attainments of 9-year-olds, 13-year-olds, 17-year-olds and adults (ages 26-35) in 10 learning areas: art, career and occupational development, citizenship, literature, mathematics, music, reading, science, social studies and writing. Different learning areas are assessed every year, and all areas are periodically reassessed in order to measure change in educational achievement.

Each assessment is the product of several years' work by a great many educators, scholars and lay persons from all over the country. Initially, these people design objectives for each area, proposing general goals that they feel Americans should be achieving in the course of their education. After careful reviews, these objectives are then given to exercise (item) writers, whose task it is to create measurement tools appropriate to the objectives.

When the exercises have passed extensive reviews by subject-matter specialists, measurement experts and lay persons, they are administered to probability samples. The people who comprise those samples are chosen in such a way that the results of their assessment can be generalized to an entire national population. That is, on the basis of the performance of about 2,500 9-year-olds on a given exercise, we can generalize about the probable performance of all 9-year-olds in the nation.

After assessment data have been collected, scored and analyzed, National Assessment publishes reports to present the results as accurately as possible. Not all exercise results are released for publication. Because NAEP will administer some of the same exercises again in the future to determine whether the performance level of Americans has improved or declined, it is essential that they not be released in order to preserve the integrity of the study. If the unreleased exercises can be discussed without revealing their content, they are examined. However, the discussion is much less detailed than it is for the released exercises.

The National Assessment also publishes a general information yearbook that describes all major aspects of the assessment process. This volume defines the categories by which results are reported and elaborates on the scientific procedures utilized. The reader who desires more detailed information about how NAEP defines

its groups, prepares and scores its exercises, designs its sample and analyzes and reports its results should consult the General Information Yearbook, Report 03/04-GIY, which is available, as are all Assessment reports, through the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

PREFACE

When the United States Office of Education was founded in 1867, one charge set before its commissioner was to determine the nation's progress in education. Only recently has that century-old charge been addressed in a systematic way. It is being done by the National Assessment of Educational Progress.

Each year since 1969, National Assessment has gathered information about levels of educational achievement across the country and reported its findings to the nation. During the first five years of its endeavors, NAEP has interviewed and tested more than 400,000 young Americans. Base-line data on the achievement levels of young Americans in nine learning areas -- science, social studies, music, literature, reading, writing, career and occupational development, mathematics and citizenship -- have been collected and reported.

This report, Science Technical Report: Summary Volume[1] summarizes the National Assessment study of changes in science achievement for 9-year-olds, 13-year-olds and 17-year-olds attending schools. Having assessed achievements in science twice, National Assessment can report to the American public concrete information on the progress or decline of knowledge in science. This report complements an earlier report, A Capsule Description of Changes in Science Achievement,[2] which highlighted some of the findings. The released science-change exercises are included in the exercise volume.[3]

---

[1]See the inside covers of this report for ordering National Assessment reports from the Government Printing Office.

[2]National Assessments of Science: 1969-1973, A Capsule Description of Changes in Science Achievement, Report 04-S-00, 1969-70 and 1972-73 Assessments (Washington, D.C.: Government Printing Office, 1975).

[3]Changes in Science Performance, 1969-1973: Exercise Volume, Report 04-S-20, 1969-70 and 1972-73 Assessments (Washington, D.C.: Government Printing Office, 1975).

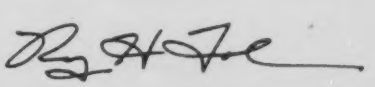
ACKNOWLEDGMENTS

Assessing changes in the science achievement of young Americans throughout the nation is an undertaking of major proportions. Certainly it could not become a reality without substantial contributions by a great number of people, not the least of whom are the students, teachers and administrators who made the effort possible to begin with. Unfortunately, it is not possible to acknowledge all the important contributions to the Assessment, and an apology is due to those whose names have been omitted.

Original preparation of the objectives and exercises in the science area was completed by the Educational Testing Service. Dozens of consultants -- both subject-matter specialists and lay persons -- reviewed these materials under the general guidance of the National Assessment of Educational Progress (NAEP) staff. Administration of exercises was handled by the Research Triangle Institute and the Measurement Research Center (MRC). Scoring and processing were carried out by MRC and by NAEP staff members.

Special acknowledgment must go to Dr. Ralph W. Tyler; to the Analysis Advisory Committee (ANAC) of National Assessment, which developed the details of the plan for measuring change; and especially to the Science Panel of ANAC (SPANAC) chaired by Dr. John Tukey of Princeton University, which has initiated or reviewed all of the analysis procedures used to report changes in levels of achievement. Without their consistent support and advice, both on technical and general matters, this endeavor could not have come to pass.

The preparation of this report was a collaborative effort of the National Assessment staff. Special thanks must go to Ingrid VanRoyen, Hugh Cobb and David Lyon of the Data Processing Department; Dr. Robert C. Larson, director of the Analysis and Research Department; Anne Kleb, research assistant; and to Dr. Judith M. Sauls of the Analysis and Research Department, who wrote this report.



Roy H. Forbes
Project Director

HIGHLIGHTS OF THE FINDINGS

National Findings

The results of this study indicate that knowledge of fundamental scientific facts and principles as measured by National Assessment declined among American students between 1969 and 1973. A comparison of the results for the 1969-70 national science assessment with the 1972-73 national science assessment indicated that in general 9-year-olds, 13-year-olds and 17-year-olds tended not to perform as well as they did three to four years earlier.

Regions

While Northeastern, Central and Western performance levels all declined, Southeastern performance remained about the same or showed a slight improvement. Thus, the gap between the Southeast and the nation narrowed from 1969 to 1973.

Boys and Girls

The difference between the performance of boys and girls in science remained stable between 1969 and 1973. Boys outperformed girls in 1969-70 and continued to do so in 1972-73. This difference was especially noticeable on physical science exercises, less so on biological exercises. In addition, the difference between boys' and girls' performance increased with age.

Blacks and Whites

The difference between black and white performance remained very large and persisted regardless of the type of science assessed. Black performance did not decline as much over the three-to-four year interval at ages 9 and 17 but seemed to have declined more at age 13.[1]

---

[1]For information on how the changes in black and white performance differed by region, see Science Achievement: Racial and Regional Trends, 1969-73, Report BRS-1, 1969-70 and 1972-73 Assessments (Washington, D.C.: Government Printing Office, 1976).

Size and Type of Community (STOC)

At ages 9 and 13, the performance of respondents living in rural areas improved between the first and second assessments and did not decline as much as the nation at age 17. As a result, the rural respondents improved their relatively low standing at all three ages. Students from the affluent areas of large metropolitan cities (high metro) at all three ages outperformed all the other STOC categories in both assessments, although their performance declined at about the same rate as the nation. Students attending schools in the poorer sections of large metropolitan cities, characterized by high unemployment and many on welfare (low metro), were typically the lowest achieving of the STOC categories; these students did not improve their position between the first and second assessments.

CHAPTER 1

INTRODUCTION

The National Assessment of Educational Progress has now completed two major assessments of science. The first took place in the 1969-70 school year, and the second occurred in the 1972-73 school year.[1] These represent the first comprehensive assessments ever attempted of the educational attainments of Americans in science and provide concrete information about changes in the levels of science knowledge of American youth between 1969 and 1973 as measured by National Assessment exercises.

In the first National Assessment study in 1969-70, 9-year-olds, 13-year-olds and 17-year-olds attending school[2] (age levels that mark the end of primary, intermediate and secondary education) were asked a variety of questions designed to measure achievement of four broad educational objectives in science. These objectives were (1) that Americans should know some fundamental facts and principles of science, (2) that they should possess some abilities and skills needed to engage in the process of science, (3) that they should understand the investigative nature of science and (4) that they should have formed attitudes about science and should appreciate its role in the culture.

Approximately one-half of the questions asked in 1969-70 were repeated in 1972-73. Using the same exercises again in a controlled manner,[3] National Assessment was able to measure the improvements and declines in attainment between the two science assessments. This report focuses on the results of these two

---

[1]The assessment schedule varied for each age level. The actual administration dates were:

9-year-olds	Jan.-Feb. 1970	Jan.-Feb. 1973
13-year-olds	Oct.-Dec. 1969	Oct.-Dec. 1972
17-year-olds	March-May 1969	March-May 1973

[2]Although 17-year-olds not attending school were also assessed, this report gives results only for 17-year-olds attending school.

[3]A few procedures did change so that some conditions were not identical between the two assessments of science. See Appendix A for more information on these procedural changes.

assessments and on the technical problems that have been encountered in interpreting the observed changes.

The Samples Used

Each year National Assessment selects respondents at age 9, 13 and 17 using a deeply stratified, multistage probability sample. This procedure guarantees that each respondent is selected with a known probability; hence, each respondent represents a known fraction of the entire population at that age level. By weighting each respondent's performance inversely to his or her probability of selection, National Assessment can make appropriate generalizations to the entire population of 9-year-olds, 13-year-olds and 17-year-olds.

National Assessment does not follow up specific individuals. The students who participated in the 1969-70 assessment were not the same ones who participated in 1972-73. In both assessment years participants were carefully selected to represent each age level.

For example, National Assessment assessed one probability sample of 9-year-olds to ascertain science achievement in 1970 and another totally different probability sample in 1973. Both sampled the population of students who were 9 years old during that assessment year. Thus, when we say that 9-year-old achievement declined, we mean that those who were 9 years old in 1970 correctly answered the same questions more often than those who were 9 years old in 1973.

The three age levels selected for participation in the two science assessments were identified as follows:

Age Level	First Assessment	Second Assessment
9	Born in 1960	Born in 1963
13	Born in 1956	Born in 1959
17	Born between October 1951 and September 1952	Born between October 1955 and September 1956

At each age level, National Assessment assessed the performance of certain categories of respondents. Results are reported for respondents categorized according to the variables sex, race, region of the country, highest level of parental education, and size and type of community. The categories used in this report are defined as follows.

Region

The students belong to four regions of the country -- Southeast, Northeast, Central and West.

Sex

Summary data in this report gives results for boys and girls. We focus on the differences between boys and girls and on how these differences changed between 1969-70 and 1972-73.

Race

National Assessment collects data for blacks, whites and others. The differences in science achievement between blacks and whites are analyzed in this report.

Size and Type of Community[4]

The categories within this variable are defined by the size of the community in which a student's school is located and by an occupational profile of the area the school serves, as judged by the school's principal. All population sizes are based on data from the 1970 Census.

Extreme rural. These schools are in areas where a high proportion of the residents are farmers or farm workers. At least some of the enrollment is from open country or places less than 2,500 population; no enrollment is from places greater than 10,000, and none is from suburbs of large cities.

Low metro (low-socioeconomic or impoverished urban). These schools serve neighborhoods where a high proportion of the resi-

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[4]Some of the STOC category names have changed since the results of the first science assessment were reported. However, the basic definitions remain the same. The category names are as follows:

1969-70	1972-73
Extreme rural	Extreme rural
Extreme inner city	Low metro
Affluent suburb	High metro
Rest of big city	Main big city
Suburban fringe	Urban fringe
Medium city	Medium city
Small city	Small places

dents are on welfare or are not regularly employed. They are located in cities or residential areas of big cities with populations greater than 200,000.

High metro (high-socioeconomic or affluent urban and suburban communities). A high proportion of the residents in these areas are professional or managerial. The schools are in big cities or residential areas of cities with populations greater than 200,000.

Main big city. Schools in this category are located in big cities of population greater than 200,000 but not included in either the low-metro or high-metro categories.

Urban fringe. These schools are in the urbanized areas near big cities of size greater than 200,000 and not included in either the low-metro or high-metro categories.

Medium city. These schools are in cities with populations between 25,000 and 200,000 that are not urbanized areas near big cities.

Small places. Schools in this category are located in open country or are from places with populations of less than 25,000, not including those in the extreme-rural category.

Parental Education

These categories are based on the highest reported level of parental education attained by either parent, ranging from "no-high-school" to "post-high-school" education. The level is determined by asking each respondent how much school both his mother and his father completed (see Appendix A for the exact wording of the questions). From 1969-70 to 1972-73 there was a minor change in the wording of these questions. Since the effect of changes in wording cannot be estimated, we are reporting these results in the appendix only. The following categories are used:

No high school. Neither parent completed schooling beyond the eighth grade.

Some high school. At least one parent completed some schooling in grades 9 through 12; neither completed high school.

Graduated high school. At least one parent graduated from high school; neither participated in post-high-school education.

Post high school. At least one parent had some education beyond high school.

Unknown. These respondents indicated that they did not know the level of education of either parent.

* * * * * * * * * * * * * *

The distinction between cross-sectional and longitudinal approaches is especially important for interpreting changes in categories of respondents. National Assessment does not report changes on the same respondents; it reports changes on the same categories of respondents, such as those living in the Southeast or those attending schools in extreme-rural areas. The same category of respondents might have somewhat different characteristics from one assessment to the other.

The longer the time between assessments, the more these respondents might differ. The Southeast, for example, might become more urbanized or its racial composition might change due to migration between regions. The extreme-rural respondents in any given year are defined as the 10% attending the most extreme-rural schools; schools classified as extreme rural one year may not be the most extreme rural in the next assessment due to population shifts, consolidation of schools and so on.

Every attempt has been made to keep the category definitions constant, although we know some changes in the compositions of these categories occurred between 1969-70 and 1972-73.[5] Some of these changes are explored in Chapter 7. National Assessment's cross-sectional approach reports changes for certain categories of respondents, regardless of the changes that might have occurred naturally to these categories over time.

The Exercises Used

The exercises used to report changes in science achievement were originally written for the first assessment of science administered in 1969-70. About half of the exercises used in that administration were not released to the public so that they could be used in the second assessment of science to measure changes in achievement. A few released exercises from the first assessment were also administered in the second assessment as part of a research effort on the effect of releasing exercises (see Appendix A for the results of this study). Both released and unreleased exercises made up the entire pool of exercises for measuring change in science. There were 92 such exercises at age 9, 67 at age 13

[5]The impact of changing proportions on the change data is explored in Appendix C.

and 64 at age 17.[6] About two-thirds of these exercises are available to the public and can be found in Changes in Science Performance, 1969-1973: Exercise Volume.[7] The remaining one-third of these exercises will be used in the next assessment of science (currently scheduled for 1976-77) to monitor change over three points in time.

The repeated science exercises were originally written to measure the 1969-70 science objectives. These objectives were designed to encompass the objectives of science education both within and outside of the schools and were reviewed by educators, scientists and lay people who agreed that they were worthwhile objectives for students aged 9, 13 and 17. The objectives were:

I. Know fundamental facts and principles of science.

II. Possess the abilities and skills needed to engage in the processes of science.

III. Understand the investigative nature of science.

IV. Have attitudes about and appreciations of scientists, science and the consequences of science that stem from adequate understandings.

Descriptions of behaviors that would indicate achievement of the objectives are given in the booklet Science Objectives,[8] which also describes their development.

Each of the repeated exercises was written for one of these objectives. Most of the exercises were classified under Objective I, as Table 1 shows.

In preparation for the 1972-73 assessment, the original science objectives, developed in 1965, were reviewed and revised to reflect the changing goals of science education. As before, lay

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[6]Two types of repeated exercises are not included in this report: (1) self-report exercises asking the respondent how often he or she did something, such as doing scientific experiments outside of school; and (2) open-ended exercises that had different scoring procedures for the two assessments on which data are consequently not being released. Change data on self-report items are available in Changes in Science Performance, 1969-1973: Exercise Volume.

[7]Changes in Science Performance, 1969-1973: Exercise Volume, Report 04-S-20, 1969-70 and 1972-73 Assessments (Washington, D.C.: Government Printing Office, 1975).

[8]Science Objectives, 1969-70 National Assessment of Science (Denver, Colo.: Education Commission of the States, 1969).

TABLE 1. Number of Exercises Per 1969-70 Objectives, by Age

	1969-70 Objectives				
	I. Facts	II. Abilities and Skills	III. Understanding	IV. Attitudes	Total Number of Exercises
Age 9	58	21	8	5	92
Age 13	50	9	5	3	67
Age 17	53	8	3	0	64

people, educators and scientists participated in the development of the new objectives. According to the 1972 objectives booklet,[9]

> The basic individual ideas of the 1965 science objectives survived an extensive process of review and revision; very few additional objectives were introduced during the preparation of the 1970 revised science objectives. This attests to the careful work that went into the original document and reaffirms the statement made therein to the effect that the National Assessment Project "had not produced a new set of objectives....Rather, these objectives represented a reorganization, a restatement and something of a summarization of objectives that frequently had appeared in print...."
>
> Two major changes in the science objectives occurred during the revision process: (1) the basic structure for presentation was altered to a hierarchical grid and (2) the objectives were stated behaviorally. These changes bring the science objectives into better alignment and current thinking in science.

From this review three major objectives emerged describing expected behaviors:

I. Know the fundamental aspects of science.

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[9]Science Objectives for 1972-73 Assessment (Denver, Colo.: Education Commission of the States, 1972), p. 7.

II. Understand and apply the fundamental aspects of science in a wide range of problem situations.

III. Appreciate the knowledge and processes of science, the consequences and limitations of science, and the personal and social relevance of science and technology in our society.

Each primary objective[10] was divided into subobjectives that dealt with the fundamental aspects of science:

A. Facts and simple concepts.
B. Laws (principles).
C. Conceptual schemes.
D. Inquiry skills.
E. The scientific enterprise.

The resulting grid displays the relationships between the 1972-73 objectives and subobjectives:

Objectives	Fundamental Aspects of Science				
	Facts and Simple Concepts	Laws (Principles)	Conceptual Schemes	Inquiry Skills	The Scientific Enterprise
Know	(I A)	(I B)	(I C)	(I D)	(I E)
Understand and Apply	(II A)	(II B)	(II C)	(II D)	(II E)
Appreciate	(III A)			(III B)	(III C)

The exercises used in the second assessment of science came from two sources: (1) exercises assessed in 1969-70 that would

[10] Objective III had only three subobjectives. Subobjective A measured appreciation of facts and simple concepts, laws (principles) and conceptual schemes. Subobjective B measured appreciation of inquiry skills, and C measured appreciation of the scientific enterprise.

be used to measure change in 1972-73 and (2) new exercises to be administered in 1972-73 for the first time. The new objectives were used as guidelines for developing the new exercises. The repeated exercises, although not written for this new set of objectives, were reclassified using the new set of objectives. In view of the relation to the 1969-70 objectives, we see a heavy concentration on the knowledge and understanding/application objectives (Table 2).

TABLE 2. Number of Exercises Per 1972-73 Objectives, by Age

	1972-73 Objectives			
	I. Know	II. Understand/ Apply	III. Appreciate	Total Number of Exercises
Age 9	40	47	5	92
Age 13	37	28	2	67
Age 17	34	30	0	64

In this report, we summarize changes in performance for both sets of objectives, since both contain information on how well students were performing in relation to important goals for science education.

A third classification was also used to describe the repeated science exercises. Each one was classified by the type of science it most closely measured: P -- physical science, B -- biological science, U -- unclassified (or other). These classifications did not change from the first to second assessments. At each age the majority of the exercises are based on topics in physical science.

	P	B	U	Total
Age 9	50	27	15	92
Age 13	36	23	8	67
Age 17	39	20	5	64

Results are also reported by the type of science assessed.

Measuring Change

Measuring Change on Exercises

Change on an exercise was measured by subtracting the 1969-70 proportion correct from the 1972-73 proportion correct.[11] If the difference is positive, there were more correct responses in 1972-73 on that exercise than in 1969-70. If it is negative, there were fewer correct responses in the second assessment than in the first.

For example, 13-year-olds were asked the following question (Exercise 101103-2) in both assessments.

> An average serving of which of the following foods would provide the most protein for building and repairing body tissues?
>
> ○ Boiled potatoes
>
> ○ Green beans
>
> ● Lean meat
>
> ○ Oatmeal
>
> ○ White bread
>
> ○ I don't know.

In 1969, 53% of the 13-year-olds correctly chose lean meat as the best protein source. In 1972, 49% of the 13-year-olds chose the correct answer, a drop of 4%. With approximately 3.5 million 13-year-olds in the nation, a 4% drop means that if all 13-year-olds had responded to that question, approximately 140,000 fewer 13-year-olds would have answered the question correctly in 1972 than in 1969.

Category Comparisons

Changes in the performance of categories of respondents were measured in two different ways: (1) by changes in the percentage

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[11] Every proportion reported by National Assessment is an estimate of the proportion of a certain age group who would have responded correctly if they all had taken the exercise. The estimated proportion is based on carefully selected respondents who represent the entire age group.

of success for that category and (2) by changes in their position relative to the nation. By observing these two changes we can determine, first, how the 1972-73 proportion correct compares with that of 1969-70 and, second, how the category's performance changed relative to that of the nation as a whole. Both types of information contribute to an understanding of how the performance of a given category of respondents changed. The following example illustrates these two types of change data.

This exercise (101077-1) was asked of 9-year-olds in 1970 and again in 1973.

Putting sand and salt together makes

- ○ a chemical.
- ○ a compound.
- ○ an element.
- ● a mixture.
- ○ a solution.
- ○ I don't know.

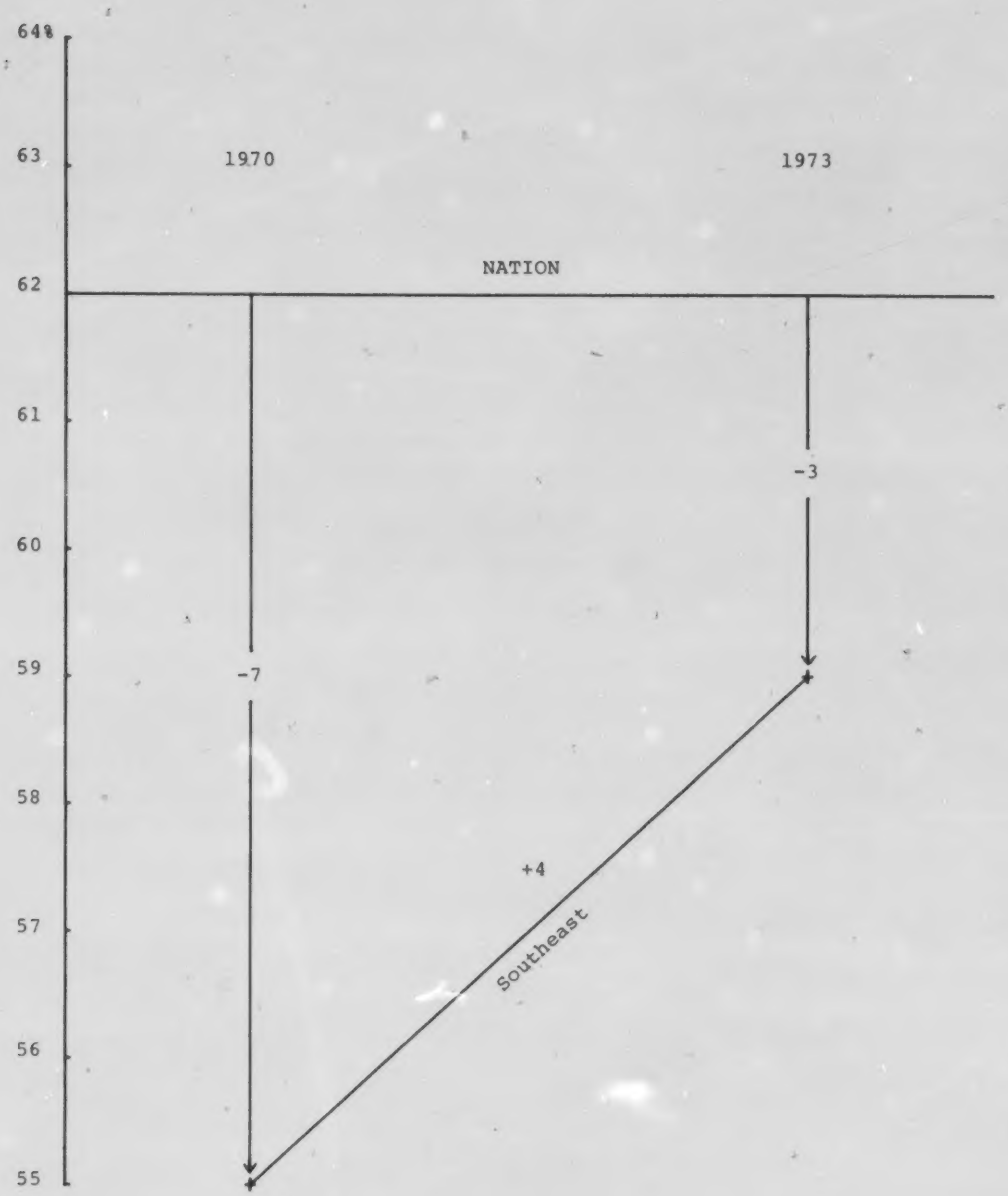
In the first science assessment, 62% of the 9-year-olds correctly identified that putting sand and salt together makes a mixture. In that same year, 55% of the Southeastern 9-year-olds chose the correct answer, 7 percentage points fewer than the national percentage correct. When asked the identical question in 1973, again 62% of the 9-year-olds answered the question correctly; there was no change in the national performance. But the Southeastern 9-year-olds responded better in 1973 than they did in 1972. Their percentage correct rose to 59%, an improvement of 4 percentage points from 1970. Since the national level remained the same, the Southeastern performance showed a gain in its relative position.

Although Southeastern performance on this exercise was still below the national level in 1973, there was considerable improvement relative to the Southeastern achievement of 1970. The gap between national performance and the performance of Southeastern 9-year-olds appreciably narrowed between the two assessments on this exercise. These changes are displayed in Exhibit 1.

Summarizing Changes in Performance

To obtain a general picture of the changes in science achievement, the gains and losses observed on each exercise were sum-

EXHIBIT 1. An Example of Change in Southeastern Performance on Exercise 101077-1



	1970	1973	Change
All 9-year-olds	62%	62%	0%
Southeastern 9-year-olds	55	59	+4
Difference between Southeast and nation	-7	-3	+4

marized using the mean, or arithmetic, average.

The mean was chosen as the principal measure of change because of its effectiveness as a summary statistic only after extensive investigation of alternative measures.[12] In addition, since the mean is an easily understood and fairly well-known statistic and has simple arithmetic properties useful for the analysis of differences (e.g., change measures), it is used exclusively in the text of this report. For comparability with other National Assessment reports, some median changes are also listed in Appendix B.

The advantages of means for measures of change need not carry over to the summarization of individual assessments. Notice that the mean percentage correct should not be compared from one age to another, as its value reflects the choice of exercises just as thoroughly as it reflects the abilities of students.

When only a few exercises are summarized by a mean, or any other measure of central location, we should be especially cautious since a small set of exercises cannot adequately cover the range of behaviors necessary to measure a given topic. Having a large number of exercises helps to compensate for this problem. In this report, the number of exercises used to calculate any measure of central location is given so that the reader may be alerted to its stability.

Estimating the Variability of Change Measures

National Assessment conducts a sample survey using a national probability sample of respondents at each age level to estimate the proportion of people who can successfully complete an exercise. The particular sample selected is one of a large number of all possible samples of the same size that could have been selected

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[12] Twenty-two empirical distributions of the type encountered by NAEP were used to generate Monte Carlo simulations of sampling distributions for several measures of central location. In addition to the mean and median, other measures of central location that were considered in the simulation studies included the average of the extremes, two forms of biweighted estimates and three forms of weight-matching estimators described by John W. Tukey in the research report "Some Considerations on Locators Apt for Some Squeezed-Tail (and Stretched-Tail) Parents" (paper prepared in connection with research at Princeton University supported by the Army Research Office, Summer 1975). In almost every case, the sampling stability of the mean was as good as or better than those of the other measures studied.

using the same sample design. Statistics computed from each of the possible samples would differ from each other. The standard error of these statistics is a measure of the sampling variability among all possible samples. A standard error, based on one particular sample, serves to estimate that sampling variability. The size of the particular sample drawn also affects the size of the standard error; in general, the larger the sample, the smaller the standard error and the greater the precision of the sample statistic as an estimate of the population number.

The standard error of a sample statistic can be used to construct a confidence interval for the estimate. The interval from one standard error above to one standard error below the particular sample value would include the population value about 68% of the time. The interval between two standard errors above and below the sample value would include the population value about 95% of the time. These intervals are called the 68%- and 95%-confidence intervals to indicate how certain or confident we are that the interval we construct contains the population number being estimated. The average value of all possible samples may or may not be contained in any particular computed interval. But we can expect 95% of such intervals to contain the true average.

In this report, National Assessment presents standard errors for individual-exercise percentages, for changes in percentages correct and for each mean. Each standard error was calculated using the jackknife procedure.[13]

The standard error of a difference based on independent samples (e.g., change in the percentage correct on an exercise from the first to the second assessment) was estimated by:

$$SE_{P_2 - P_1} = \sqrt{SE_{P_2}^2 + SE_{P_1}^2}$$

where P_1 and P_2 refer to two percentages based on independent samples.

When two samples are not independent (e.g., comparison of Southeastern performance to the entire nation, including the Southeast), we must take into account the overlap between the two groups

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[13] F. Mosteller and J. W. Tukey, "Data Analysis Including Statistics," in Handbook of Social Psychology (2nd ed.), eds. E. Aronson and G. Lindzey (Reading, Mass.: Addison-Wesley, 1968); R. G. Miller, Jr., "A Trustworthy Jackknife," Annals of Mathematical Statistics, No. 39 (1968), pp. 567-582; R. G. Miller, Jr., "The Jackknife -- A Review," Biometrika, No. 61 (1974), pp. 1-15.

of respondents. Since it is very difficult to estimate the covariance in these cases, a direct computational procedure, again using the jackknife procedure, is used to estimate the standard error of the difference.

As an example of the use of standard errors, refer to Table 3 (in Chapter 2), which lists each of the 92 repeated science exercises. For each exercise, the change in percentage correct and the standard error of that change is listed. For example, on Exercise 204124 there was a gain of 12.0 percentage points correct with a standard error of change of 1.8 percentage points. Using this standard error we can construct a 95%-confidence interval around 12.0 using ±2 times its standard error. Thus, the 95%-confidence interval is 8.4 to 15.6 percentage points. We can be 95% confident that this interval actually includes the true change for 9-year-olds on this exercise. Since the entire interval is above zero, we are 95% confident that there was a true gain on this exercise.

Not all exercises showed clear gains or losses, based on their standard errors. For example, Exercise 202078, also given to 9-year-olds in both assessments, had a gain of 2.1 percentage points with a standard error of 1.9. The 95%-confidence interval for this change is calculated using 2.1 ± 2 (1.9). Since the resulting interval, -1.7 to 5.9, includes some negative and some positive values, we are not confident even about the direction of the change. Using this interval, we know that the true change could be either a negative or a positive number.

Similar statements can be made about mean changes. In this report, statements about the significance of gains and losses are based on 95%- confidence intervals.

CHAPTER 2

NATIONAL RESULTS

The data reported in this chapter are for changes in the performance of 9-year-olds, 13-year-olds and 17-year-olds attending schools. Most 9-year-olds have completed the primary grades (kindergarten through grade 3), most 13-year-olds are nearing the completion of the intermediate grades (grades 4 through 8) and most 17-year-olds are nearing completion of high school. This chapter presents the changes in science achievement for each of these three age levels.[1]

The percentages of correct responses and how these changed should also be interpreted in light of the percentage responding "I don't know" to the exercises. National Assessment data have shown that selection of "I don't know" responses varies with age and from category to category, thus differentially affecting correct responses. This problem is explored more fully in Chapter 7.

Age 9, 1970-73

National Assessment first assessed the science achievement of 9-year-olds in January and February of 1970. When 9-year-olds were assessed again in January and February of 1973, National Assessment found that the performance of 9-year-olds in 1973 was generally below that of the 9-year-olds in 1970. On 92 exercises asked in both science assessments, the performance of the 1973 9-year-olds was lower than that of the 1970 9-year-olds on about two-thirds of the exercises. On the remaining one-third, more 9-year-olds responded correctly in 1973 than in 1970. The average change in correct responses for the 92 exercises was a mean decline of 1.7 percentage points, as shown by the arrow in Exhibit 2. With a standard error of 0.6 percentage points, this mean change has a 95%-confidence interval of -2.9 to -0.5 percentage points.[2] Since this interval does not include zero (which would indicate no change) or any positive numbers, we are at least 95% confident that there was an actual decline in the average performance of 9-year-olds on the 92 repeated exercises.

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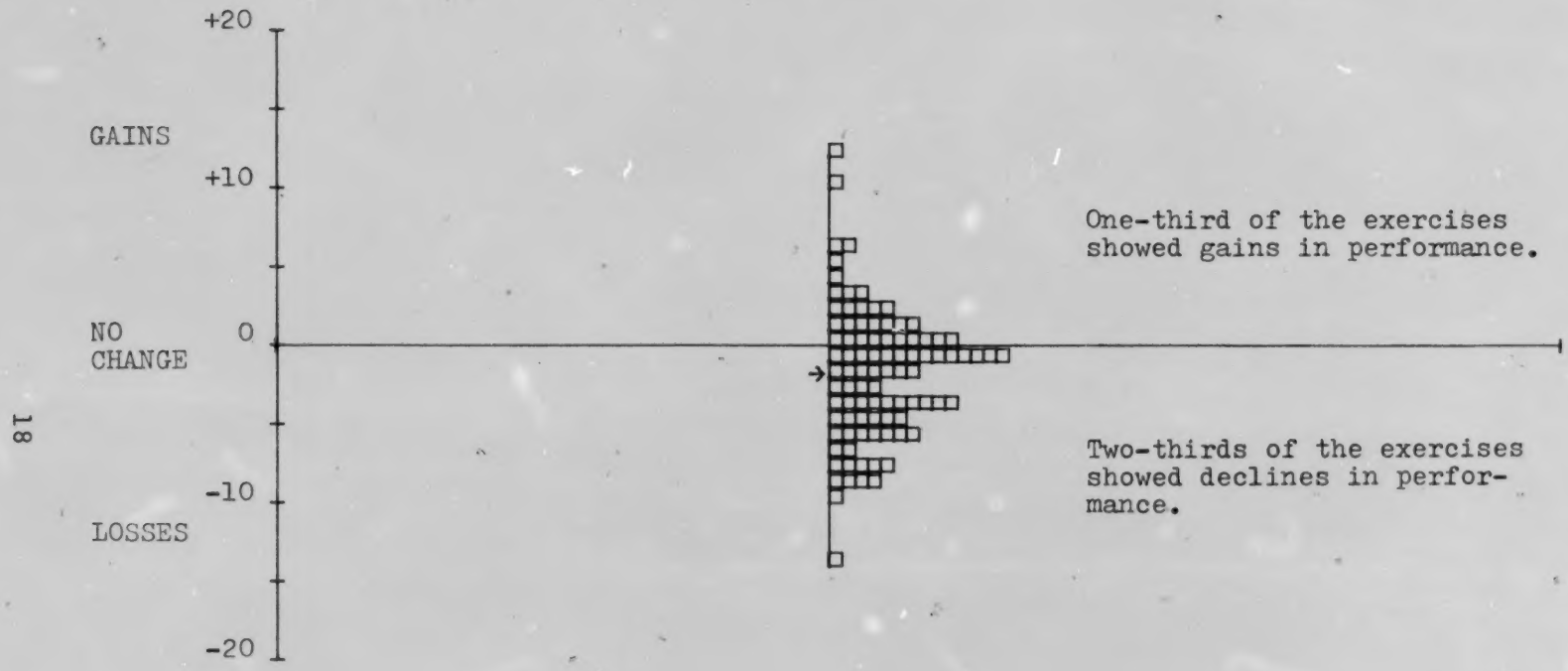
[1]All summary data can be found in Appendix B.
[2]The Introduction gives a discussion of the usage of confidence intervals.

EXHIBIT 2. Changes in Science Achievement for 9-Year-Olds, 1970-73



Each box -- 1% high -- represents the change in performance on one of the 92 repeated science exercises.
The arrow indicates the mean change of -1.7 percentage points.

Table 3 lists the 92 exercises in order from high to low based on their changes in performance. The changes ranged from a gain of 12.0 percentage points ("To fix his bicycle, John must find where the air leaks out of it") to a loss of 13.2 percentage points ("Most of the earth's surface is water").

The following list ("Key to Tables 3, 4 and 5...") gives a key to the exercise-level information found in this list. Exact copies of the released exercises as they appeared in both assessments together with more detailed documentation, including timing and data for selected categories of respondents, can be found in the Exercise Volume.[3]

* * * * * * * * * * * * * *

Key to Tables 3, 4 and 5: Lists of Repeated Exercises Ordered by National Change

Column Heading	Description
NAEP #	The first three numbers identify the 1972-73 objective and subobjective. Example: 204104 identifies this exercise as measuring the 1972-73 Objective IID. The major objectives were: I. Know the fundamental aspects of science. II. Understand and apply the fundamental aspects of science in a wide range of problem situations. III. Appreciate the knowledge and processes of science, the consequences and limitations of science, and the personal and social relevance of science and technology in our society. The subobjectives are described in the Introduction of this report.

[3]Changes in Science Performance, 1969-1973: Exercise Volume, Report 04-S-20, 1969-70 and 1972-73 Assessments (Washington, D.C.: Government Printing Office, 1975).

1969-70 Obj.	The number identifies the 1969-70 objective being measured. I. Know fundamental facts and principles of science. II. Possess the abilities and skills needed to engage in the processes of science. III. Understand the investigative nature of science. IV. Have attitudes about and appreciations of scientists, science and the consequences of science that stem from adequate understandings.
Type of Science	This letter indicates the type of science measured. P = physical science. B = biological science. U = unclassified or other.
Description of Exercise	A short description of the exercise is given for released exercises. The text of the unreleased exercises is not reported so they can be used to measure change again in the third assessment of science.
1969-70 National % Correct	This is a population estimate of the proportion of respondents correctly answering the exercises in 1969 or 1970.
1972-73 National % Correct	This is a population estimate of the proportion correct in 1972 or 1973.
Change	Change is calculated by subtracting the 1969 % correct from the 1973 % correct. All exercises are ordered from high to low by their change values.
Standard Error of Change	This value is reported in parentheses following the change value and can be used to estimate the stability of the change.

NOTE: Copies of the released exercises and more detailed documentation of the exercises including timing and data for selected categories of respondents can be found in the Changes in Science Performance, 1969-1973: Exercise Volume.

TABLE 3. List of Repeated Exercises Given to 9-Year-Olds, Ordered by National Change

NAEP #	1969-70 Obj.	Type of Science	Description of Exercise	1969-70 National % Correct	1972-73 National % Correct	Change	Standard Error of Change
204124	II	P	To fix his bicycle tire, John must find where the air leaks out of it.	75.7	87.8	12.0	(1.8)
204089	II	P	In most of the U.S., a noon temperature of 30 degrees F. is most likely in January.	52.7	62.8	10.1	(2.3)
204083	II	P	Choose the picture that is like the one John drew, but is rotated differently.	76.2	82.7	6.6	(1.8)
303085	IV	U	It is not true that all scientists wear uniforms.	62.5	68.7	6.2	(2.1)
101078	I	B	The rabbit, and not the cat, dog or lion, eats only plants.	87.7	92.7	5.0	(1.3)
201057	I	P	Text for this exercise was not released.	12.7	16.9	4.2	(1.5)
204080	II	P	Text for this exercise was not released.	47.9	51.5	3.6	(1.9)
101067	I	P	Chemistry, and not animals, plants or soil, is often called the study of matter.	37.6	41.0	3.4	(2.5)
303084	IV	U	Text for this exercise was not released.	86.0	89.1	3.1	(1.5)
201068	I	P	Ice, shoes and water can be called matter, but ideas cannot.	36.0	38.9	2.9	(2.3)
204086	II	U	If D = duck and C = cat, represent a picture of two ducks and one cat as D, D, C.	87.1	89.9	2.8	(1.6)
101086	I	B	Text for this exercise was not released.	95.5	97.7	2.3	(0.8)
202078	I	P	It is most likely to snow when the weather is cold and cloudy.	76.7	78.8	2.1	(1.9)
303086	IV	U	Text for this exercise was not released.	83.4	85.5	2.1	(1.4)
101100	I	B	The bones and shells of sea animals that lived millions of years ago can be found in the rocks in the ground.	36.8	38.7	1.9	(2.0)
101097	I	P	There are more stars in the universe than have been counted.	73.9	75.7	1.7	(1.8)
101090	I	B	Text for this exercise was not released.	41.6	43.3	1.7	(1.7)
205018	III	U	Scientists would have more trouble testing whether my dog is better than your dog than testing the other choices listed.	39.4	40.5	1.1	(2.4)
101084	I	B	Text for this exercise was not released.	81.8	82.9	1.1	(1.7)
101085	I	B	Helping to cool your body is the main way sweating helps it.	14.5	15.5	1.1	(1.5)
204088	II	B	Choose the graph that correctly shows the amount of growth of a plant that is given for each of three weeks.	54.4	55.5	1.0	(2.1)
201062	I	P	Text for this exercise was not released.	36.8	37.7	0.9	(2.0)
101087	I	P	Atoms are NOT a part of electrons; but they are part of compounds, elements, matter and molecules.	11.6	12.5	0.9	(1.5)
204072	I	P	Text for this exercise was not released.	68.3	68.7	0.5	(2.4)
201055	I	P	When it is raining there MUST be clouds in the sky.	81.4	81.8	0.4	(1.6)
204076	II	B	According to the graph, your heart probably beats fastest when you are running, and not walking, swimming or wrestling.	91.1	91.4	0.3	(1.3)
204082	II	B	Text for this exercise was not released.	91.2	91.5	0.3	(1.2)
101077	I	P	Putting sand and salt together makes a mixture instead of a chemical, element or solution.	61.5	61.7	0.2	(2.0)
101071	I	P	The Sun is hotter than Earth, Mars or the moon.	95.1	95.4	0.2	(0.8)
101069	I	P	Each year the Earth moves once around the Sun, not Mars, Venus, the moon or all the other planets.	66.5	66.7	0.2	(2.2)

TABLE 3 (cont.). List of Repeated Exercises Given to 9-Year-Olds, Ordered by National Change

NAEP #	1969-70 Obj.	Type of Science	Description of Exercise	1969-70 National % Correct	1972-73 National % Correct	Change	Standard Error of Change
105015	III	U	If you saw many scientists at work, many would be doing experiments, not selling soap, cooking meals or painting walls.	93.8	93.9	0.1	(1.0)
204078	II	P	Circle, circle, triangle are the correct symbols for the temperature recorded on each of three days.	19.3	19.1	-0.1	(1.7)
204090	II	U	Let stand a mixture of salt, sugar and water to test an idea about how salt water taffy is made.	68.9	68.7	-0.2	(1.9)
303088	IV	U	Text for this exercise was not released.	70.7	70.4	-0.3	(1.8)
101083	I	B	A bat usually hunts for food ONLY at night, but a dog, horse and hummingbird do not.	87.2	86.9	-0.3	(1.6)
101064	I	B	Choose the pictured penguin and not the duck, sparrow or robin as the bird that CANNOT fly.	92.0	91.6	-0.4	(1.2)
201058	I	P	Text for this exercise was not released.	41.3	40.8	-0.5	(2.7)
101068	I	B	Houseflies and not ants, honeybees or moths spread serious human disease.	46.0	45.5	-0.5	(2.2)
201067	I	P	A pint of water 50 degrees F. mixed with a pint of water 70 degrees F. yields water that is ABOUT 60 degrees F.	7.1	6.4	-0.7	(1.0)
204128	II	B	Read a doctor's chart to determine that younger people breathe faster than older people.	67.0	66.2	-0.7	(1.8)
101072	I	P	Physics is the study of energy and matter and not war and peace, wood and cloth, or plants and animals.	38.6	37.8	-0.8	(2.2)
201061	I	P	Glass dissolves LESS in water than salt, soap or sugar.	40.2	39.4	-0.8	(2.5)
201063	I	P	Sunshine and rain could cause a rainbow, but fog and smog, rain and snow, or clouds and ice could not.	86.6	85.7	-0.9	(1.3)
202079	I	P	Text for this exercise was not released.	57.6	56.7	-0.9	(2.0)
204079	II	B	Text for this exercise was not released.	81.2	80.2	-0.9	(1.9)
101095	I	P	Text for this exercise was not released.	78.3	77.1	-1.2	(1.7)
105010	III	U	Scientists do not know everything about any topic.	25.9	24.6	-1.3	(2.0)
101080	I	P	Text for this exercise was not released.	92.2	90.6	-1.5	(1.4)
201060	I	P	Text for this exercise was not released.	21.9	20.3	-1.6	(1.5)
101079	I	B	Germs sometimes cause disease in man because germs make poisons.	49.2	47.6	-1.6	(2.1)
303087	IV	U	It is not true that breaking a mirror brings bad luck.	72.0	70.3	-1.7	(2.0)
101075	I	B	Text for this exercise was not released.	71.1	69.2	-1.9	(2.1)
201084	II	B	Text for this exercise was not released.	63.4	61.3	-2.1	(2.2)
101101	I	P	Text for this exercise was not released.	48.3	46.0	-2.2	(1.8)
205019	III	U	Text for this exercise was not released.	22.1	19.3	-2.8	(1.7)
101092	I	B	Text for this exercise was not released.	56.6	53.7	-2.9	(2.1)
201066	I	B	When an animal breathes faster and its heart beats faster, the animal is most likely frightened.	73.3	70.2	-3.1	(1.9)
101089	I	P	Text for this exercise was not released.	94.8	91.5	-3.2	(1.0)
201065	I	P	An atom of iron is smaller than a bit, particle or molecule of iron.	20.8	17.4	-3.4	(2.0)
101074	I	P	You could measure the distance from your home to the school in yards or feet, but not dozens, pounds or quarts.	89.1	85.6	-3.5	(1.4)
101093	I	P	Water falls from the sky as hail, rain and snow, but not as smoke.	77.8	74.2	-3.6	(2.3)

TABLE 3 (cont.). List of Repeated Exercises Given to 9-Year-Olds, Ordered by National Change

NAEP #	1969-70 Obj.	Type of Science	Description of Exercise	1969-70 National % Correct	1972-73 National % Correct	Change	Standard Error of Change
201085	II	P	To find the air temperature outdoors, it would be best to put the thermometer in the shade.	11.8	8.2	-3.7	(1.3)
101076	I	P	Electricity can be used for cooking food, heating homes and lighting rooms but not for taking walks.	80.3	76.6	-3.7	(2.0)
101096	I	P	Fish can be weighed on a scale, but freedom, friendship and fun cannot.	92.9	89.2	-3.7	(1.2)
201056	I	P	Blowing on a campfire will speed up its burning, but covering it with sand, sprinkling dirt or water on it will not.	67.3	63.3	-3.9	(2.3)
204091	II	B	To know how much a person grew in one year, you must know his height at the beginning of the year.	70.3	66.4	-4.0	(2.2)
204077	II	P	It is easier to measure the length of a pencil with a 12-inch ruler than thickness of paper or distance from home.	74.3	70.2	-4.1	(1.9)
205027	III	U	In science one is less likely to write poems about apples than to weigh, measure, describe their color or count their seeds.	23.0	18.7	-4.2	(1.7)
204113	III	U	To find out which of three light bulbs is brightest, it would help if one had a way to find out the brightness of a bulb.	41.7	37.2	-4.4	(2.3)
202106	I	P	If a rock broken into three pieces is put into water, the water level will be the same as before the rock was broken.	38.2	33.7	-4.5	(1.9)
204137	II	B	To say that seeds grow best in light, one should use same seeds, not different ones, watered equally, in dark and light.	46.2	41.5	-4.6	(1.8)
205016	III	U	A scientist is likely to think, read books and plan experiments, but NOT sell tickets while he is working.	75.1	70.3	-4.7	(2.4)
204081	II	P	Choose the graph that best records the temperature at 10:00, 11:00 and 12:00.	31.3	26.2	-5.1	(2.2)
204084	II	P	Classify a cloud at 10,000 feet as a middle cloud instead of high or low using a specific scheme given.	63.7	58.6	-5.1	(2.1)
101081	I	B	A fish has scales over most of its body, but a turtle, frog and a rabbit do not.	80.9	75.7	-5.2	(2.1)
201059	I	P	Text for this exercise was not released.	33.4	28.1	-5.3	(1.7)
204087	II	B	The SUREST sign that a dog is sick is its not having eaten its food for two days.	95.6	90.3	-5.3	(1.0)
101094	I	B	Chickens, frogs and turtles lay eggs, but dogs do not.	95.8	90.4	-5.4	(1.0)
204085	II	B	Text for this exercise was not released.	66.5	61.1	-5.4	(2.2)
101088	I	B	Text for this exercise was not released.	91.3	85.2	-6.1	(1.4)
101065	I	P	Text for this exercise was not released.	53.7	47.0	-6.6	(2.7)
101082	I	P	Text for this exercise was not released.	65.1	58.0	-7.1	(2.5)
202080	I	P	A short, wide container will have less water after left in a warm place for a day than taller, more narrow ones.	69.0	61.7	-7.3	(2.0)
105009	III	U	We get scientific laws from many experiments, and not from the police, voting or Congress passing them.	33.4	26.0	-7.4	(1.9)
101070	I	B	Cockleburs are more likely to be spread by sticking to animals and being carried than maple seeds, bean pods or acorns.	69.5	61.9	-7.6	(2.2)

TABLE 3 (cont.). List of Repeated Exercises Given to 9-Year-Olds, Ordered by National Change

NAEP #	1969-70 Obj.	Type of Science	Description of Exercise	1969-70 National % Correct	1972-73 National % Correct	Change	Standard Error of Change
202081	I	P	One pint is the space a rock needs if the water level rises from five pints to six pints when the rock is added.	72.5	64.7	-7.8	(2.2)
101073	I	P	The tiny grains of sand on the beach are pieces of rock, and not drops of water, crystals of salt or splinters of wood.	61.9	53.9	-8.0	(2.1)
201064	I	P	Text for this exercise was not released.	74.9	66.6	-8.3	(2.2)
101098	I	P	Text for this exercise was not released.	63.2	54.5	-8.7	(2.2)
101091	I	P	Iron is more likely to rust when it is damp than when it is dry, painted or covered with grease or soap.	75.3	66.3	-9.0	(2.0)
201069	I	P	Wet outside of cold glass is not evaporation, but water from bird bath or dewdrops from leaf is evaporation.	34.3	24.4	-9.9	(1.7)
101099	I	P	Most of earth's surface is water, not cities and towns, farmland, solid rock or yellow.	54.4	41.2	-13.2	(2.5)

Type of Science

The 1973 9-year-olds generally did not perform as well as the 1970 9-year-olds on all three types of science measured: physical science, biological science and unclassified exercises. On physical science exercises, 9-year-olds had an average decline of 2.0 percentage points incorrect responses, with a 95%-confidence interval of -3.2 to -0.8, indicating that we are 95% confident that there was an actual decline in the performance of 9-year-olds on the 50 physical science exercises. Performance on the 27 biological exercises declined an average of 1.6 percentage points, with a 95%-confidence interval of -2.8 to -0.4. Although performance on the 15 unclassified exercises also declined (down an average of 0.8 percentage points), based on a 95%-confidence interval of -2.4 to 0.8 we cannot be very confident that there was an actual decline on these exercises. However, it is interesting that on all three types of science exercises, about one-third of the exercises showed gains from 1970 to 1973 while two-thirds showed losses (Exhibit 3).

Objectives[4]

Two sets of objectives can be used to analyze the 92 science exercises given to 9-year-olds in both assessments. The exercises were originally written to reflect the four 1969-70 objectives, the year of the first science assessment. Results by these objectives are presented in Exhibit 4. On the average, the performance of 9-year-olds declined on the first three objectives: (1) knowledge of fundamental facts and principles, (2) possession of necessary abilities and skills and (3) understanding the investigative nature of science. All but Objective II showed actual declines using 95%-confidence intervals. Average performance increased for the 5 exercises classified under Objective IV (attitudes and appreciations). This increase had a 95%-confidence interval that indicated an actual improvement on these exercises.

For the 1972-73 assessment, these same exercises were reclassified using the newly developed science objectives. The first two objectives, (1) knowledge and (2) understanding and application, showed lower average performance in 1973; the 95%-confidence intervals for these two mean changes were all below zero, indicating actual average declines (Exhibit 5). Objective III of 1972-73 contained the same five exercises as Objective IV of 1969-70.

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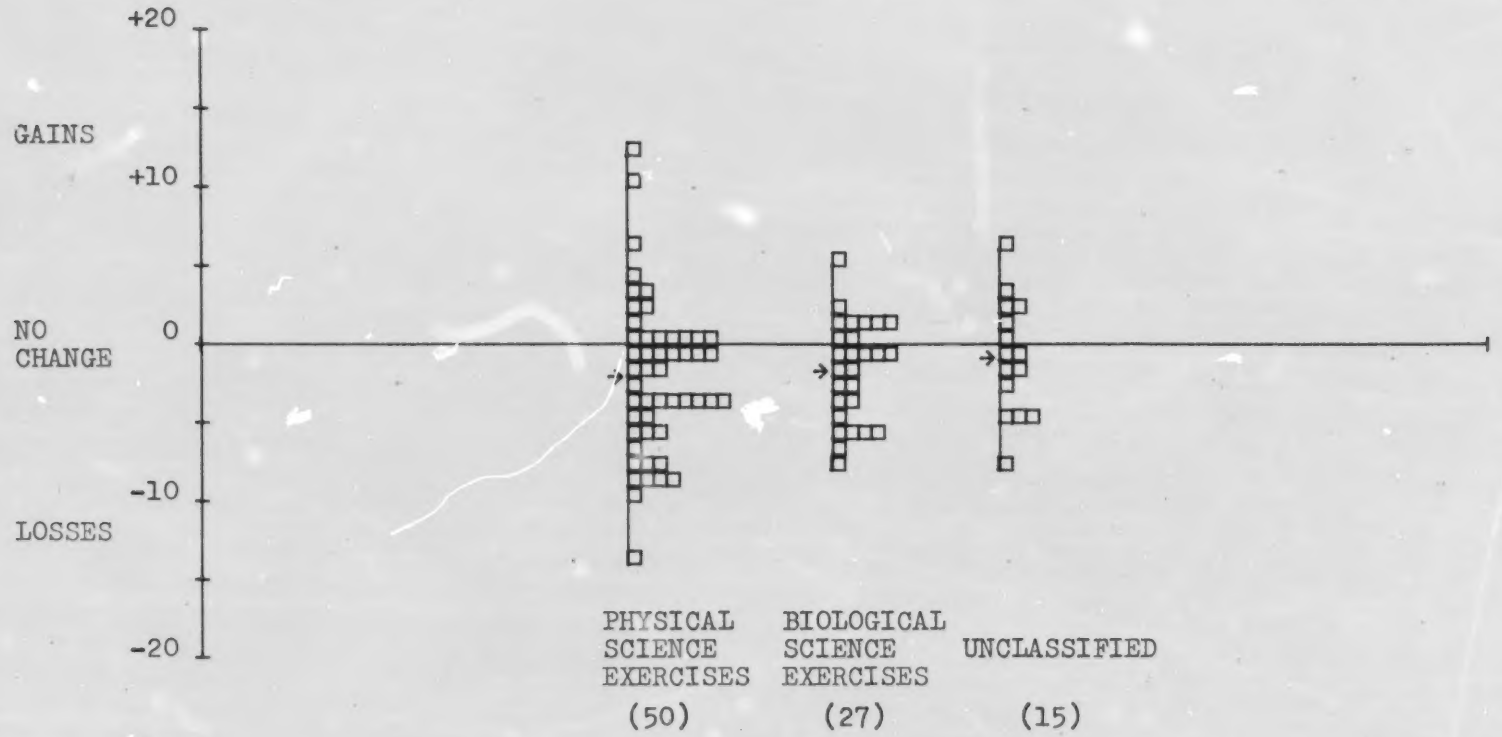
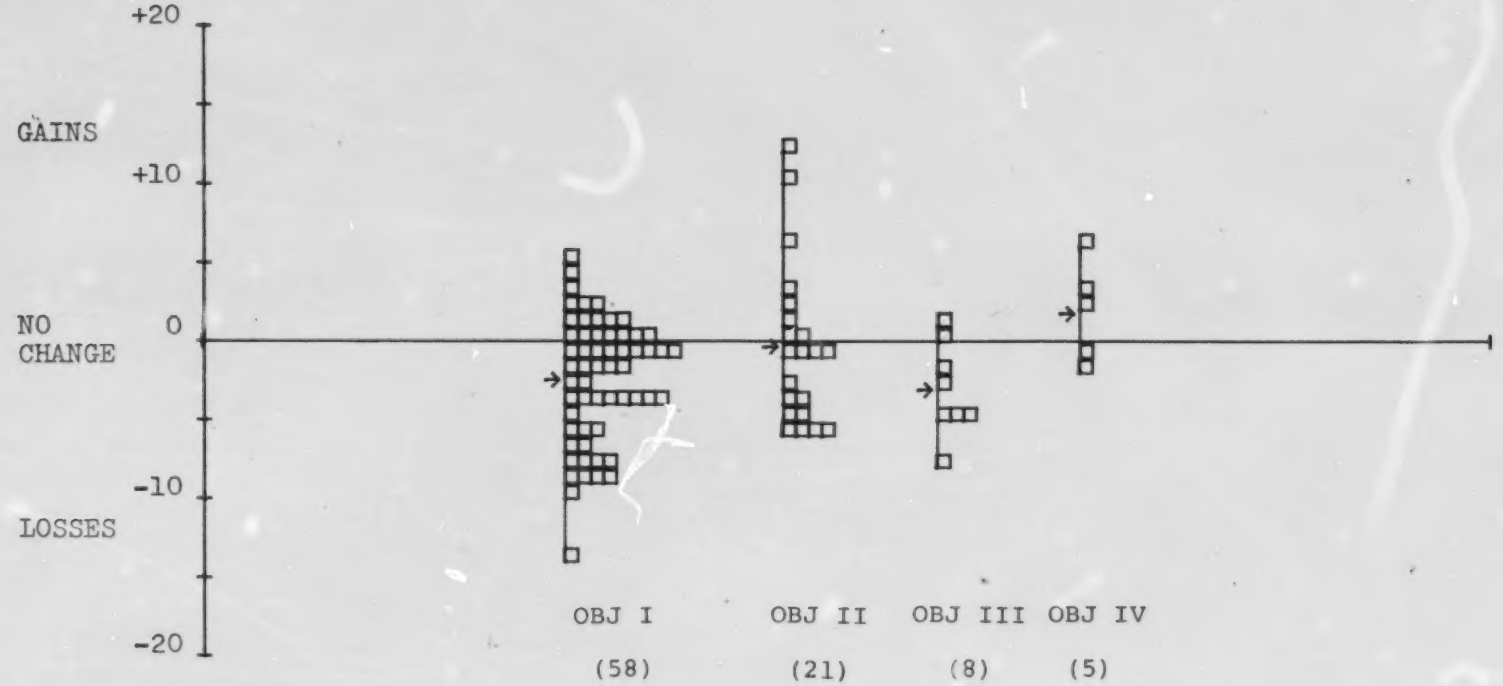
[4]For more detail on the development of the 1969-70 and 1972-73 objectives, see the Introduction.

EXHIBIT 3. Changes in Science Achievement by Type of Science for 9-Year-Olds, 1970-73



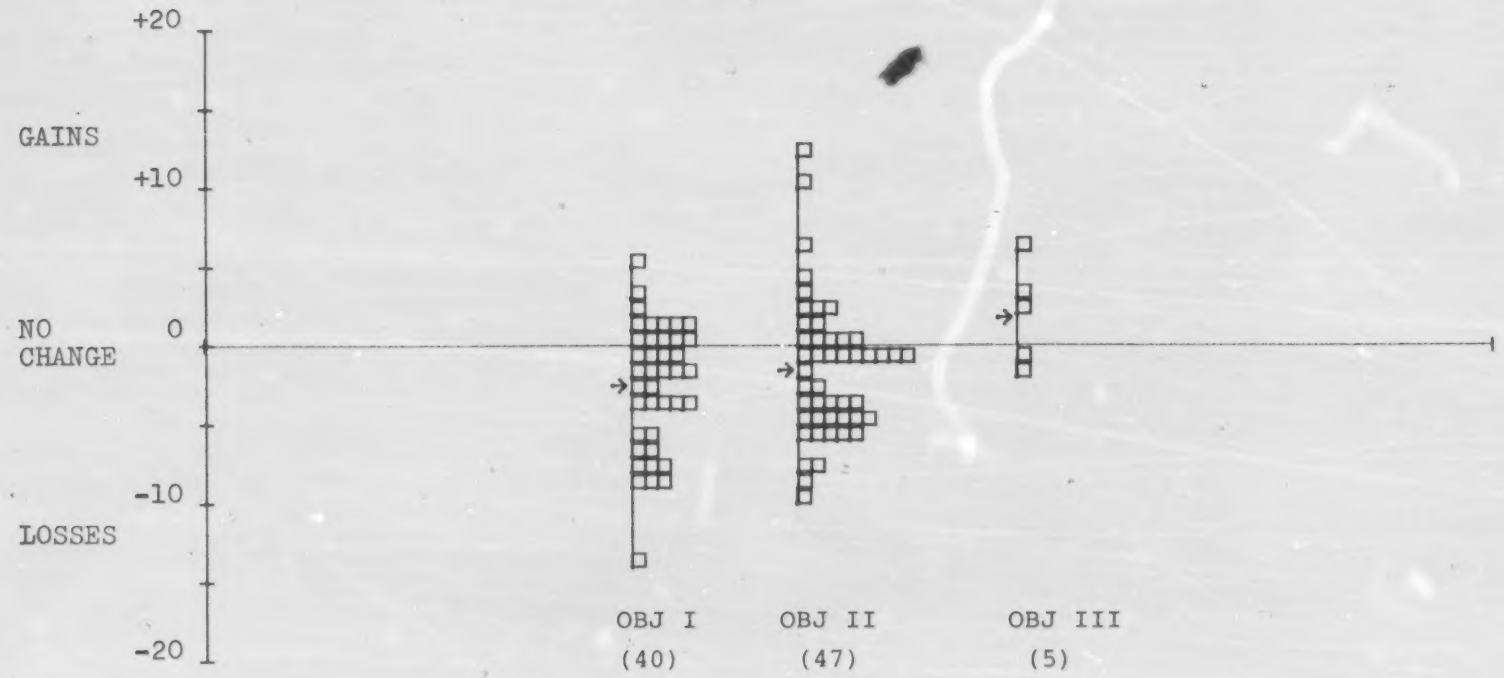
Each box -- 1% high -- represents the change in performance on one science exercise.
Arrows indicate the mean change: -2.0 percentage points for physical science, -1.6 for biological science and -0.8 for unclassified exercises.

EXHIBIT 4. Changes in Science Achievement by 1969-70 Objectives for 9-Year-Olds, 1970-73



Each box -- 1% high -- represents the change in performance on one science exercise.
Arrows indicate the mean change: -2.3 percentage points for Objective I, -0.2 for Objective II, -3.0 for Objective III and 1.9 for Objective IV.

EXHIBIT 5. Changes in Science Achievement by 1972-73 Objectives for 9-Year-Olds, 1970-73



Each box -- 1% high -- represents the change in performance on one science exercise.
Arrows indicate the mean change: -2.4 percentage points for Objective I, -1.4 for Objective II and 1.9 for Objective III.

Age 13, 1969-72

The performance of 13-year-olds, like that of 9-year-olds, was generally lower in 1972 than in 1969. Both assessments of 13-year-olds took place in the fall (October through December) of those years. Sixty-seven identical exercises were used in both of these assessments. The performance of the 1972 13-year-olds was lower than that of the 1969 13-year-olds on about two-thirds of the exercises; 1972 performance was better than that of 1969 on the remaining one-third of the exercises. Over all 67 exercises, the average change in correct responses was a decline of 1.9 percentage points, as shown by the arrow in Exhibit 6. With a standard error of 0.6, we have a 95%-confidence interval for this mean change of -3.1 to -0.7.[5] Since this interval contains only negative numbers, we are at least 95% confident that the average performance of 13-year-olds declined from 1969 to 1972 on these science exercises.

Table 4 lists these 67 exercises in order from high to low according to the size of the change in correct responses. The largest gain was 7.8 percentage points on an exercise termed "Of three blocks with equal volume, the one that floats the lowest is the heaviest." The largest decline was 9.0 percentage points on an unreleased, physical science exercise dealing with fundamental facts and simple concepts (Objective IA of 1972-73).

Type of Science

The average performance of 13-year-olds declined on physical and biological exercises but increased on the unclassified exercises. About four-fifths of the physical science had a worse performance in 1972 than in 1969; only one-fifth showed better 1972 performance. The average performance of 13-year-olds declined 2.7 percentage points on these 36 physical science exercises, with a 95% confidence of -4.1 to -1.3. On the 23 biological exercises, there was a smaller average decline, 1.4 percentage points with a 95%-confidence interval of -2.8 to 0.0. Thirteen-year-olds in 1972 did better than the 1969 13-year-olds on about half of the biological science exercises. Thus, on both physical and biological exercises, we are at least 95% confident that the performance of 13-year-olds declined between 1969 and 1972. On the 8 unclassified exercises, there was an average improvement of 0.5 percentage points but with a 95%-confidence interval of -1.3 to 2.3, which contains both positive and negative numbers; we cannot be very confident about the actual direction of that change (Exhibit 7).

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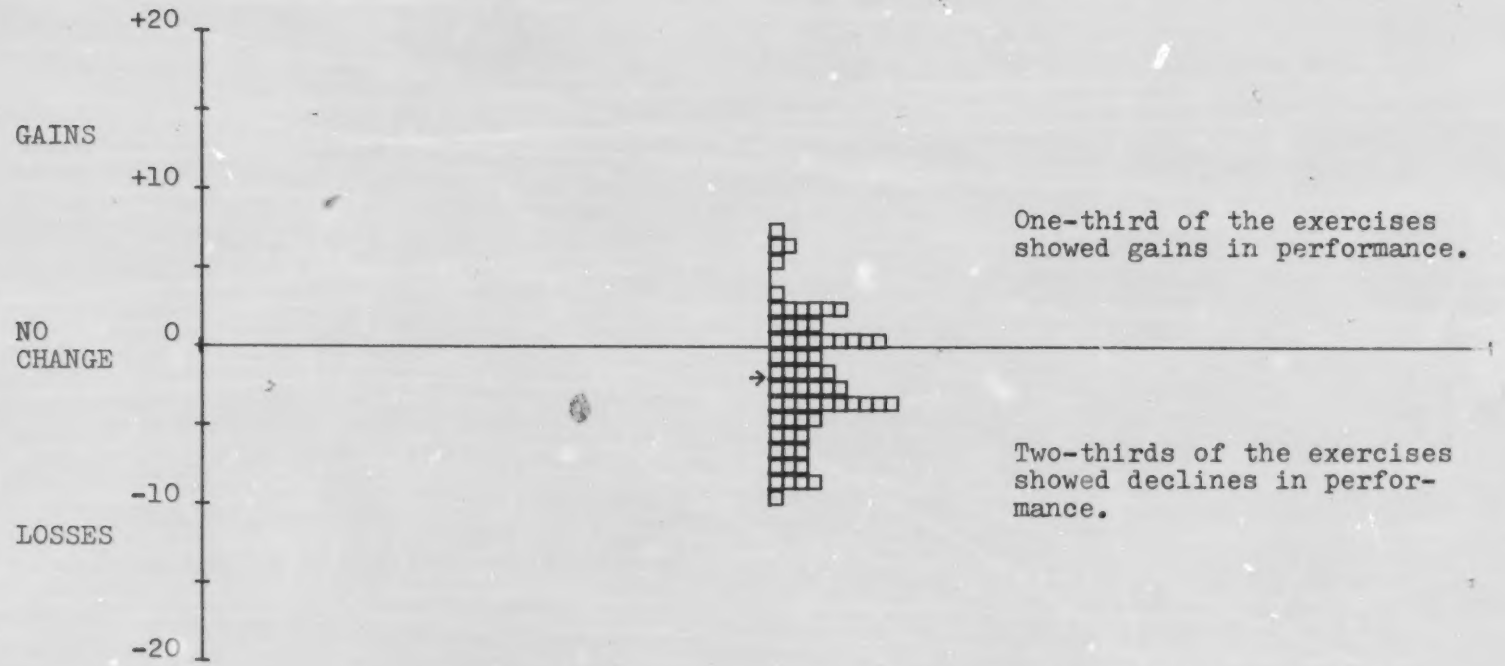
[5]See the Introduction for the construction and meaning of confidence intervals.

EXHIBIT 6. Changes in Science Achievement for 13-Year-Olds, 1969-72



Each box -- 1% high -- represents the change in performance on one of the 67 repeated science exercises.
The arrow indicates the mean change of -1.9 percentage points.

TABLE 4. List of Repeated Exercises Given to 13-Year-Olds, Ordered by National Change

NAEP #	1969-70 Obj.	Type of Science	Description of Exercise	1969-70 National % Correct	1972-73 National % Correct	Change	Standard Error of Change
202102	II	P	Of three blocks with equal volume, the one that floats the lowest is the heaviest.	75.1	82.9	7.8	(1.6)
303089	IV	U	It is not true that most scientists today are working on space projects.	37.9	44.8	7.0	(2.1)
101101	I	P	Text for this exercise was not released.	61.8	68.5	6.8	(2.1)
203022	I	B	In terms of natural selection, giraffes with longest necks got food when scarce, and passed this trait onto their young.	38.4	44.2	5.8	(1.9)
101124	I	P	All kinds of matter can be formed from atoms, not compounds, mixtures or protons.	58.2	61.4	3.3	(2.4)
101104	I	B	Text for this exercise was not released.	34.6	37.5	2.9	(2.1)
101125	I	B	Man has probably been on earth shorter than alligators, dragonflies, fish or snails.	61.6	64.2	2.6	(2.2)
101110	I	P	Energy and not conservation, efficiency, friction or magnetism is needed to move cars, heat hamburgers and light rooms.	79.2	81.6	2.4	(1.8)
201104	I	B	You should lay a person down and keep him warm when he faints.	31.5	33.7	2.2	(1.8)
205018	III	U	Scientists would have more trouble testing whether my dog is better than your dog than the other choices listed.	72.5	74.5	2.0	(1.8)
105011	III	U	Text for this exercise was not released.	45.9	47.9	2.0	(2.2)
105012	IV	U	It is true that most scientists have gone to school many years.	92.0	93.9	1.9	(0.9)
102029	I	P	Text for this exercise was not released.	40.5	42.1	1.6	(2.1)
101109	I	B	Green plants are important to man because they produce food and give off oxygen.	49.7	51.1	1.4	(1.9)
101105	I	B	Nerves, not arteries, glands, muscles or veins carry the message from the eyes to the brain when one sees something.	76.9	78.2	1.3	(1.7)
101092	I	B	Text for this exercise was not released.	94.9	95.6	0.7	(1.0)
201073	I	P	A balloon filled with air has the same mass, not size, weight, rate of fall or ability to float on the moon as on Earth.	21.2	21.5	0.4	(1.8)
101119	I	P	A powder of black and white specks is a mixture, not sugar, pepper, an element or a pure compound.	69.7	70.0	0.3	(2.0)
101118	I	P	The only star you usually see in the daytime is the Sun, not Venus, the Moon, the Pole Star, or Alpha Centauri.	93.2	93.5	0.3	(1.1)
101102	I	B	Green plants make sugar by the process called photosynthesis, not digestion, evaporation, osmosis or respiration.	61.7	62.0	0.3	(2.7)
202084	I	B	An ocean fish fossil found in a rock outcrop on a mountain probably means the mountain was raised after the fish died.	25.9	26.1	0.2	(1.9)
101112	I	B	Text for this exercise was not released.	51.7	51.8	0.1	(2.4)
302015	IV	B	It is true that planting seeds and finding out how fast they grow could be a science experiment.	93.4	93.5	0.1	(0.9)
205022	III	U	Text for this exercise was not released.	67.6	67.6	0.0	(1.9)

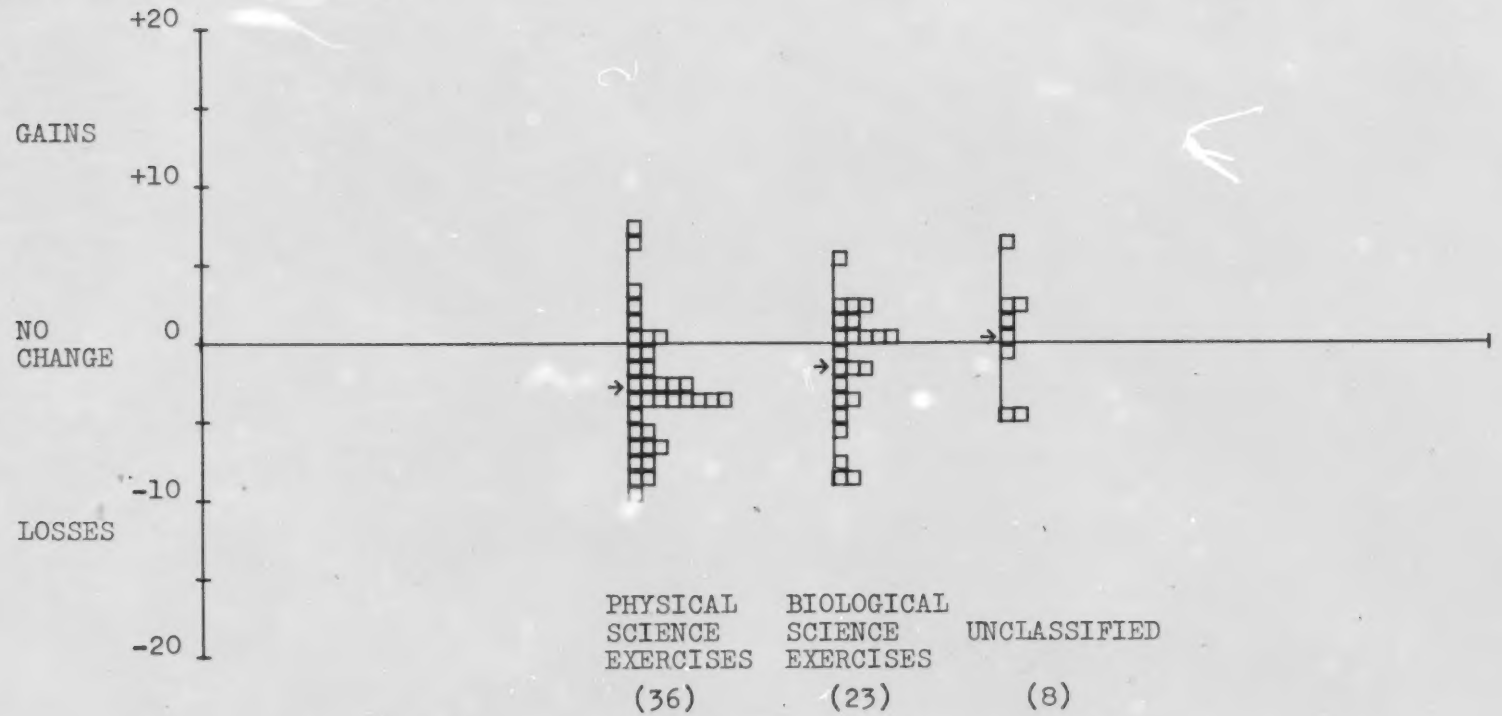
TABLE 4 (cont.). List of Repeated Exercises Given to 13-Year-Olds, Ordered by National Change

NAEP #	1969-70 Obj.	Type of Science	Description of Exercise	1969-70 National % Correct	1972-73 National % Correct	Change	Standard Error of Change
101123	I	P	Water vapor, not oxygen, nitrogen, hydrogen gas or carbon atoms in crystal form, is formed when a candle burns.	8.1	8.0	-0.1	(1.0)
205020	III	U	Text for this exercise was not released.	89.0	88.3	-0.7	(1.3)
101126	I	B	The main way sweating helps the body is as an aid in controlling body temperature.	44.3	43.4	-0.9	(2.2)
101129	I	P	A compass can be used to find north on Earth because Earth has a magnetic field.	63.1	62.2	-0.9	(2.7)
204092	II	P	If a stopper pops out of a heated test tube, the best reason given is that some of the water has changed to steam.	52.2	51.2	-1.0	(2.4)
101108	I	B	Of those listed, the most important job for the lungs is to provide a place for oxygen to enter the blood.	85.7	84.2	-1.5	(1.4)
101113	I	B	Text for this exercise was not released.	58.2	56.7	-1.5	(2.0)
204094	II	B	Text for this exercise was not released.	90.4	88.9	-1.5	(1.3)
101127	I	P	Text for this exercise was not released.	71.5	69.7	-1.8	(2.0)
204098	II	P	Text for this exercise was not released.	92.5	90.5	-2.1	(1.6)
204096	II	P	The best explanation for the fact that puddles last longer in winter is that water evaporates faster on hot days.	73.4	71.3	-2.1	(1.8)
202082	I	P	Text for this exercise was not released.	24.9	22.4	-2.6	(1.9)
204074	I	P	Text for this exercise was not released.	47.2	44.3	-2.8	(2.0)
101116	I	B	Of the listed choices, cancer is best described as uncontrolled cell division.	29.0	26.1	-2.9	(2.1)
201070	I	P	A single atom of carbon cannot be seen directly by the human eye using an ordinary-light microscope or telescope.	49.5	46.6	-3.0	(2.3)
101107	I	B	Text for this exercise was not released.	58.6	55.5	-3.0	(2.5)
101082	I	P	Text for this exercise was not released.	80.9	77.9	-3.0	(2.0)
204073	I	P	To get salt from saltwater, one could boil away the water, not cool it, add more, remove the air or dissolve air in it.	76.0	72.6	-3.4	(2.1)
201086	I	P	Heat a quart of 70 degree water to 150 degrees, and the water level will be highest in the beaker with the long, thin neck.	56.5	52.9	-3.5	(2.2)
201074	I	P	Text for this exercise was not released.	28.4	24.8	-3.6	(1.7)
101117	I	P	An electric power company sells energy, not atoms, electrons, radiation or time in kilowatt-hours.	45.5	41.9	-3.6	(2.2)
101097	I	P	There are more stars in the universe than have been counted.	93.7	89.9	-3.8	(1.0)
101128	I	P	Atoms of all elements have nuclei, not the same weights or mass or an attraction for electrons.	38.7	34.8	-3.9	(2.2)
201072	I	P	Fanning makes a fire burn better because fanning increases the oxygen supply.	78.5	74.5	-3.9	(1.9)
101103	I	B	An average serving of lean meat provides the most protein for building and repairing body tissues.	53.2	49.3	-3.9	(2.3)
204100	II	P	One needs many 13-year-olds, not scales or yardsticks to determine the average height of 13-year-olds.	63.0	59.0	-4.0	(2.5)

TABLE 4 (cont.). List of Repeated Exercises Given to 13-Year-Olds, Ordered by National Change

NAEP #	1969-70 Obj.	Type of Science	Description of Exercise	1969-70 National % Correct	1972-73 National % Correct	Change	Standard Error of Change
102030	I	B	The density of the human body is most nearly equal to the density of water, not air, cork, hydrogen or iron.	37.0	32.9	-4.0	(2.2)
204097	II	U	If 705 plants have red flowers and 224 have white the ratio of red to white is about 3:1, not 700:1, 4:1, 2:1 or 1:480.	47.0	42.9	-4.1	(2.4)
205021	III	U	A scientist is probably seeking relationships when he studies carefully the many measurements taken in an experiment.	66.6	62.1	-4.5	(1.7)
201064	I	P	Text for this exercise was not released.	93.6	88.6	-5.0	(1.5)
102022	I	P	Text for this exercise was not released.	42.5	37.0	-5.5	(1.9)
101114	I	B	Seeds come from the flower, not the bark, leaf, root or stem of the plant.	74.4	68.4	-5.9	(1.8)
101111	I	P	If a neutral atom loses an electron, an ion, not a gas, an acid, a radical, or a molecule is formed.	28.4	21.8	-6.7	(2.3)
102021	I	P	Text for this exercise was not released.	60.4	53.4	-7.0	(2.9)
203023	I	P	If a ball is dropped on the sidewalk from a height of one yard, it could bounce 5/8 yard high.	47.5	40.5	-7.0	(2.0)
101069	I	P	Each year the Earth moves once around the Sun, not Mars, Venus, the moon or all the planets.	82.5	75.5	-7.0	(1.9)
202083	I	P	It takes the most energy to stop a heavy car going 40 miles per hour from the choices given.	68.0	60.9	-7.1	(1.8)
101122	I	B	Malaria, not cancer, diabetes, measles or polio is the disease known to be transmitted by an insect.	84.6	77.0	-7.6	(2.1)
201071	I	B	If all green plants died, man would sooner or later die of starvation.	50.5	42.5	-8.1	(2.0)
101120	I	P	The time it takes the Moon to go from new moon to full moon and back to new moon is about 28 days.	58.5	50.3	-8.2	(2.2)
202095	II	P	Text for this exercise was not released.	72.2	63.9	-8.3	(2.6)
204095	II	B	That Siamese cats are prettier than other cats is an opinion rather than a fact about cats.	79.3	70.8	-8.5	(2.1)
101115	I	P	Text for this exercise was not released.	53.3	44.3	-9.0	(2.8)

EXHIBIT 7. Changes in Science Achievement by Type of Science for 13-Year-Olds, 1969-72



Each box -- 1% high -- represents the change in performance on one science exercise.

Arrows indicate the mean change: -2.7 percentage points for physical science, -1.4 for biological science and 0.5 for unclassified exercises.

Objectives[6]

The 67 repeated exercises given to 13-year-olds in both assessments can be classified according to two sets of objectives -- those of the first assessment, for which they were originally written, and those of the second assessment. The changes in performance by each set of objectives are displayed in Exhibits 8 and 9 (only those objectives with five or more exercises are displayed). The average performance of 13-year-olds was lower in 1972 than in 1969 on the first three objectives of 1969-70: (1) knowledge of fundamental facts and principles, (2) possession of necessary abilities and skills and (3) understanding the investigative nature of science. Based on 95%-confidence intervals, there were actual declines for Objectives I and II but not for III. Performance on the three exercises of Objective IV (attitudes and appreciation) showed an actual average improvement, again based on a 95%-confidence interval.

When the exercises were reclassified using the 1972-73 objectives, average performance declined on Objectives I (knowledge) and II (understanding and application) based on 95%-confidence intervals. Average performance on the two exercises under Objective III (appreciation) actually improved.

Age 17, 1969-73

Four years, rather than three years, separated the two science assessments of 17-year-olds. The first was conducted in March through May of 1969; the second, March through May of 1973. In both assessments, National Assessment administered exercises to two groups of 17-year-olds: those enrolled in school at the time of the assessment and those not enrolled in school (dropouts or early graduates). However, due to different administration procedures used for the out-of-school respondents in the two assessments, change results are presented only for 17-year-olds attending school.

Of the three school-age groups, the 17-year-olds showed the largest average decline in performance on repeated science exercises. As shown in Exhibit 10, the average performance of 17-year-olds dropped 3.2 percentage points, with a 95%-confidence interval of -4.2 to -2.2,[7] indicating we are at least 95% confident that

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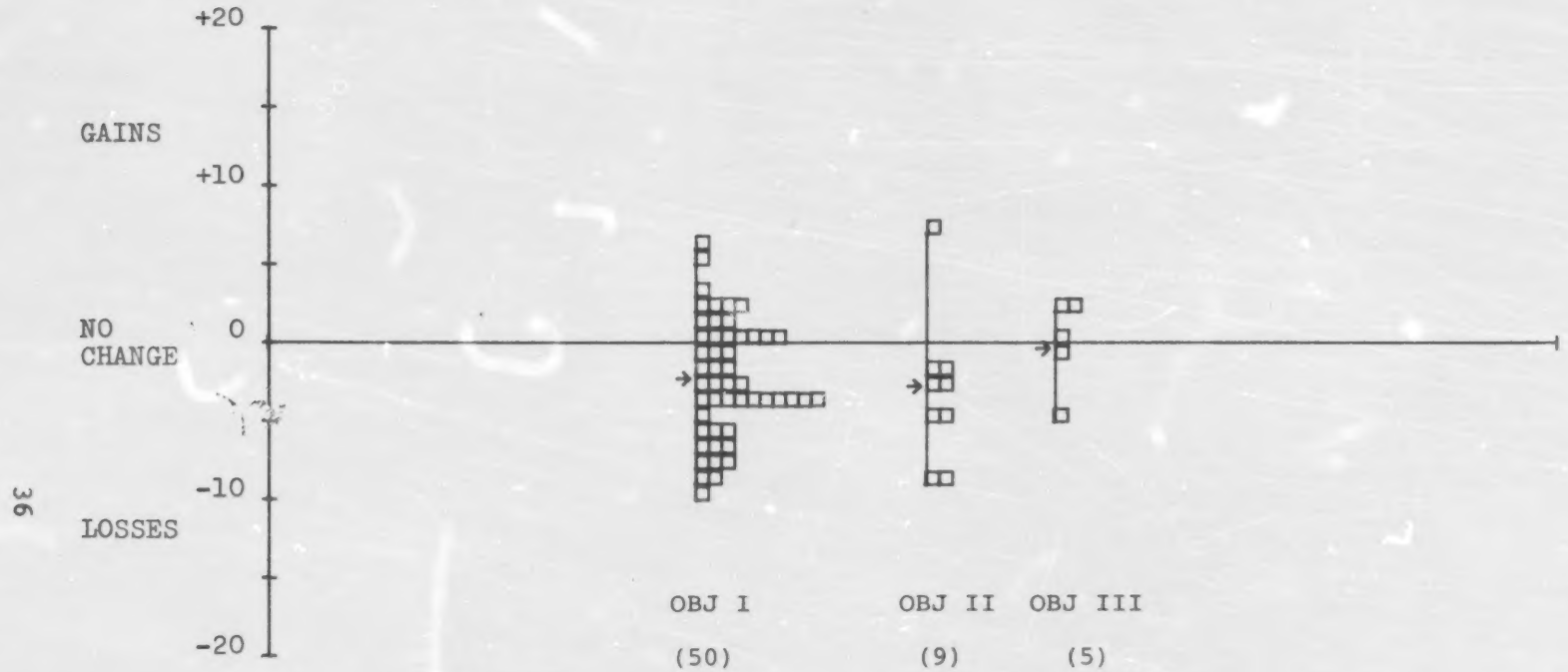
[6]For more detail on the development of the 1969-70 and 1972-73 objectives, see the Introduction.

[7]The standard error of the mean change was 0.5. The Introduction gives a discussion of the usage of confidence intervals.

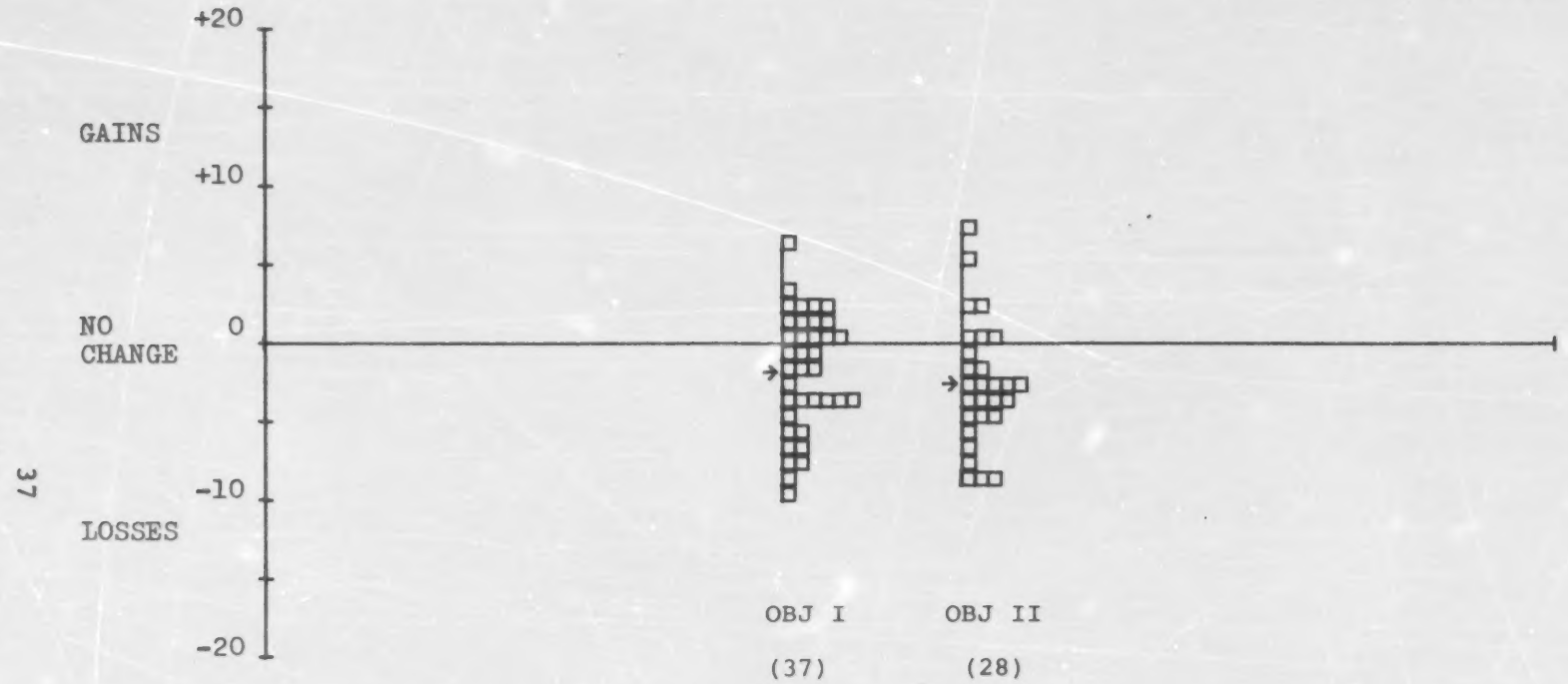
EXHIBIT 8. Changes in Science Achievement by 1969-70 Objectives for 13-Year-Olds, 1969-72



Each box -- 1% high -- represents the change in performance on one science exercise.

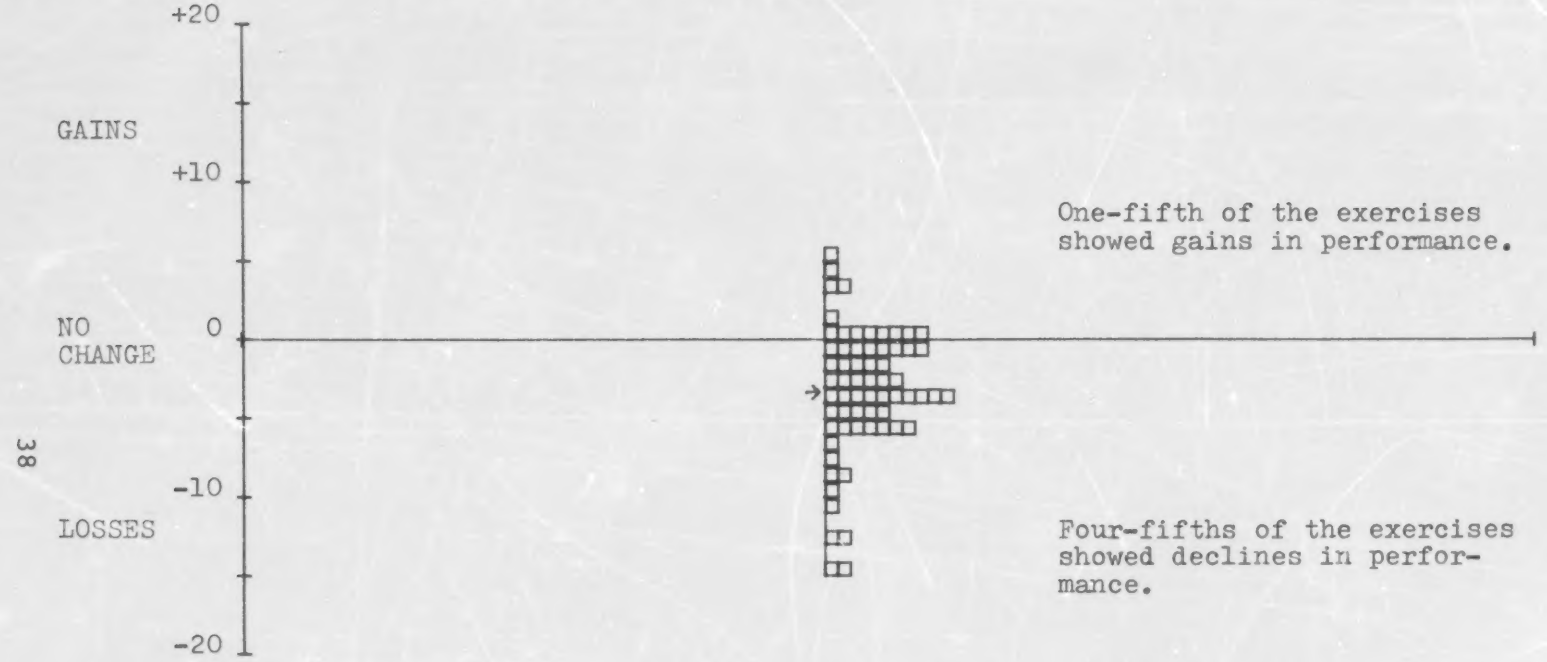
Arrows indicate the mean change: -2.2 percentage points for Objective I, -2.7 for Objective II and -0.2 for Objective III.

EXHIBIT 9. Changes in Science Achievement by 1972-73 Objectives for 13-Year-Olds, 1969-72



Each box -- 1% high -- represents the change in performance on one science exercise.
Arrows indicate the mean change: -1.7 percentage points for Objective I and -2.4 for Objective II.

EXHIBIT 10. Changes in Science Achievement for 17-Year-Olds Enrolled in School, 1969-73



71

72

Each box -- 1% high -- represents the change in performance on one of the 64 repeated science exercises.
The arrow indicates the mean change of -3.2 percentage points.

an actual decline occurred. Performance improved on one-fifth of the exercises.

If 17-year-olds had been assessed only three years apart, and assuming the changes in performance were fairly steady across years, their average change might have been closer to a decline of 2.4[8] percentage points rather than the observed decline of 3.2 percentage points.

Table 5 lists each repeated exercise given to 17-year-olds in both assessments. The exercises are listed in order from high to low by change in percentage correct. The changes ranged from an improvement of 5.6 percentage points (the human embryo normally develops in the uterus) to a decline of 14.3 percentage points (transformer is a device for changing the voltage of an electric power supply). In general, these changes are lower than those observed at ages 9 and 13.

Type of Science

The average performance of 17-year-olds declined on all three types of science exercises: physical, biological and unclassified. Performance was down an average of 4.0 percentage points on physical science exercises, with a 95%-confidence interval of -5.0 to -3.0. Performance improved on only 5 of the 39 physical science exercises. The declines were generally smaller on the biological science exercises: the mean change was a decline of 1.6 percentage points. However, its 95%-confidence interval, -2.8 to -0.4, was still below zero, indicating that we can be 95% confident that there was an actual decline on these exercises. Performance was better in 1973 than in 1969 on about 30% of the biological exercises. The 17-year-olds did not do much better on the 5 unclassified exercises, which showed an average decline of 3.7 percentage points and a 95%-confidence interval of -5.5 to -1.9 (Exhibit 11).

Objectives

When the exercises were classified by objectives, all groups of exercises showed average declines in performance that had 95%-confidence intervals below zero. The average performance of 17-year-olds dropped about 3 to 4 percentage points under the original objective of 1969 (Exhibit 12) as well as under the revised ones of 1973. There were no exercises classified under Objective III (appreciation) of 1972-73 (Exhibit 13).

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[8] (3/4) x 3.2 = 2.4.

TABLE 5. List of Repeated Exercises Given to 17-Year-Olds, Ordered by National Change

NAEP #	1969-70 Obj.	Type of Science	Description of Exercise	1969-70 National % Correct	1972-73 National % Correct	Change	Standard Error of Change
101134	I	B	The human embryo normally develops in the uterus, not the abdominal cavity, ovary, oviduct or vagina.	46.7	52.2	5.6	(2.6)
101112	I	B	Text for this exercise was not released.	62.3	66.5	4.2	(2.1)
101127	I	P	Text for this exercise was not released.	78.4	81.5	3.1	(1.6)
101135	I	B	Insulin, not estrogen, iodine, penicillin or thyroxine is used in the treatment of diabetes.	76.8	79.8	3.0	(2.2)
201074	I	P	Text for this exercise was not released.	47.2	49.0	1.9	(2.6)
202093	I	P	A copper wire with alternating current, connected to a direct-current source near a magnet's N. pole would NOT vibrate.	23.0	23.7	0.7	(2.0)
101159	III	U	A scientific model is best described as a scheme that guides one's thinking about something not completely known.	17.5	18.0	0.5	(1.5)
101157	III	U	Text for this exercise was not released.	4.0	4.4	0.5	(0.9)
204111	II	B	That plants use starch in seeds & give off gases that escape explains why a flask with corn planted in it loses weight.	19.6	20.0	0.4	(1.7)
201081	I	B	Text for this exercise was not released.	12.0	12.3	0.3	(1.3)
201080	I	B	Raindrop imprints are NOT fossils but brachipod shells, dinosaur footprints, fish bones and worm trails are.	71.8	72.0	0.3	(1.7)
202089	I	P	The resistance of the parallel connection of a 4 ohm and a 12 ohm resistor will be about 3, not 8, 12, 16 or 48 ohms.	8.7	8.8	0.1	(1.3)
204108	II	P	Text for this exercise was not released.	21.5	21.5	0.1	(2.0)
202088	I	P	The spring balance nearest the weight will have a higher reading than the one farther away.	74.8	74.7	-0.1	(1.9)
101146	I	P	The particles that make up atoms are usually said to be protons, neutrons and electrons.	84.6	84.2	-0.5	(1.6)
101147	I	P	Metal cans for holding foodstuffs are chiefly made of iron, not copper, nickel or tin.	3.0	2.5	-0.5	(0.6)
201075	I	P	A catalyst in a chemical system cannot change the amounts of products and reactants present at equilibrium.	21.8	21.2	-0.6	(1.8)
201078	I	P	The fact that Earth has a natural satellite, Moon, is the only one given that does NOT classify Earth as a planet.	13.2	12.4	-0.8	(1.3)
101151	I	P	A weather map usually shows lows, highs, cold fronts, areas where it is raining, but not mileages between major cities.	96.1	95.2	-1.0	(0.6)
202092	I	B	A vegetable should be added to a meal of milk, bread and butter, meat and cake to satisfy the rules of good nutrition.	98.2	97.2	-1.0	(0.6)
101150	I	P	Particles most directly involved in forming chemical bonds are electrons, not neutrons, photons, positrons or protons.	51.7	50.7	-1.0	(2.3)
202087	I	B	Mineral fertilizer around a plant may cause it to die because the amount of water at the roots has been decreased.	16.4	15.4	-1.0	(1.4)
101148	I	B	On the average, in human females, the egg is released 14, not 2, 9 or 20 days after menstruation begins.	29.0	27.8	-1.2	(2.1)

TABLE 5 (cont.). List of Repeated Exercises Given to 17-Year-Olds, Ordered by National Change

NAEP #	1969-70 Obj.	Type of Science	Description of Exercise	1969-70 National % Correct	1972-73 National % Correct	Change	Standard Error of Change
101131	I	B	A frog is a vertebrate, but a clam, octopus, spider and starfish are not.	72.4	71.0	-1.4	(2.2)
101145	I	B	Text for this exercise was not released.	22.2	20.6	-1.5	(1.9)
202090	I	P	During electrolysis, 1.0 faraday of electrons can produce 1.0 gram-atom of Ag from $AgNO_3$ solution.	4.1	2.2	-1.8	(0.7)
101133	I	B	A lizard is an animal, but bacterium, moss, snapdragon and toadstool are not.	87.7	85.7	-2.0	(1.5)
101115	I	P	Text for this exercise was not released.	75.6	73.4	-2.2	(2.1)
101130	I	B	Text for this exercise was not released.	5.5	3.2	-2.3	(1.0)
101149	I	P	Text for this exercise was not released.	56.7	54.2	-2.5	(2.4)
201077	I	P	Text for this exercise was not released.	40.8	38.3	-2.6	(2.3)
204105	II	P	The graph pictured represents the equation $Y = X$, not $Y = aX^2$, $Y = 2X$, $YX = 1$ or $X^2 + Y^2 = 1$.	73.4	70.8	-2.6	(1.9)
202082	I	P	Text for this exercise was not released.	34.0	30.9	-3.1	(2.3)
101140	I	B	Text for this exercise was not released.	93.3	90.1	-3.2	(1.4)
101142	I	P	If a sudden change took place on the surface of the Sun, it could first be observed on Earth after about 8 minutes.	30.9	27.5	-3.4	(1.9)
204075	I	P	The graph with the negative exponential shows how the pressure of a gas sample changes as its volume changes.	18.6	15.2	-3.5	(1.3)
202091	I	P	Start from rest, accelerate to reach a speed of 10 meters per sec. in 5 sec. and the acceleration will be $2m/sec^2$.	26.2	22.7	-3.5	(1.8)
101144	I	P	Text for this exercise was not released.	79.3	75.8	-3.5	(1.6)
204104	II	B	Text for this exercise was not released.	60.7	57.0	-3.6	(2.2)
202085	I	B	When a purebred black guinea pig is bred with a white one, all of the offspring will be black.	48.0	44.2	-3.8	(2.3)
202086	I	P	Text for this exercise was not released.	29.3	25.5	-3.8	(1.8)
101153	I	P	A refrigerator keeps its contents cool by transferring heat, not freshening food, or destroying energy.	44.8	40.9	-3.9	(2.1)
102025	I	P	Text for this exercise was not released.	67.5	63.4	-4.2	(2.0)
101116	I	B	Of the listed choices, cancer is best described as uncontrolled cell division.	61.6	57.1	-4.5	(2.1)
201079	I	P	In hot climates, the advantage of buildings with white surfaces is that they reflect, not absorb or refract light.	72.1	67.6	-4.5	(2.0)
204103	II	U	That the rings of Saturn were formed when a moon exploded is a hypothesis rather than a fact.	66.3	61.3	-4.9	(2.4)
101123	I	P	Water vapor, not oxygen, nitrogen, hydrogen gas or carbon atoms in crystal form is formed when a candle burns.	15.3	10.4	-5.0	(1.7)
203022	I	B	In terms of natural selection, giraffes with longest necks got food when scarce, and passed this trait onto its young.	60.2	55.1	-5.1	(2.1)
102024	I	P	Text for this exercise was not released.	28.7	23.6	-5.1	(1.7)
101136	I	P	Oxygen & silicon, not iron & copper, or oxygen & hydrogen make up the greatest part of the mass of the Earth's crust.	13.6	8.4	-5.2	(1.6)
101143	I	P	Text for this exercise was not released.	27.0	21.4	-5.6	(1.8)

TABLE 5 (cont.). List of Repeated Exercises Given to 17-Year-Olds, Ordered by National Change

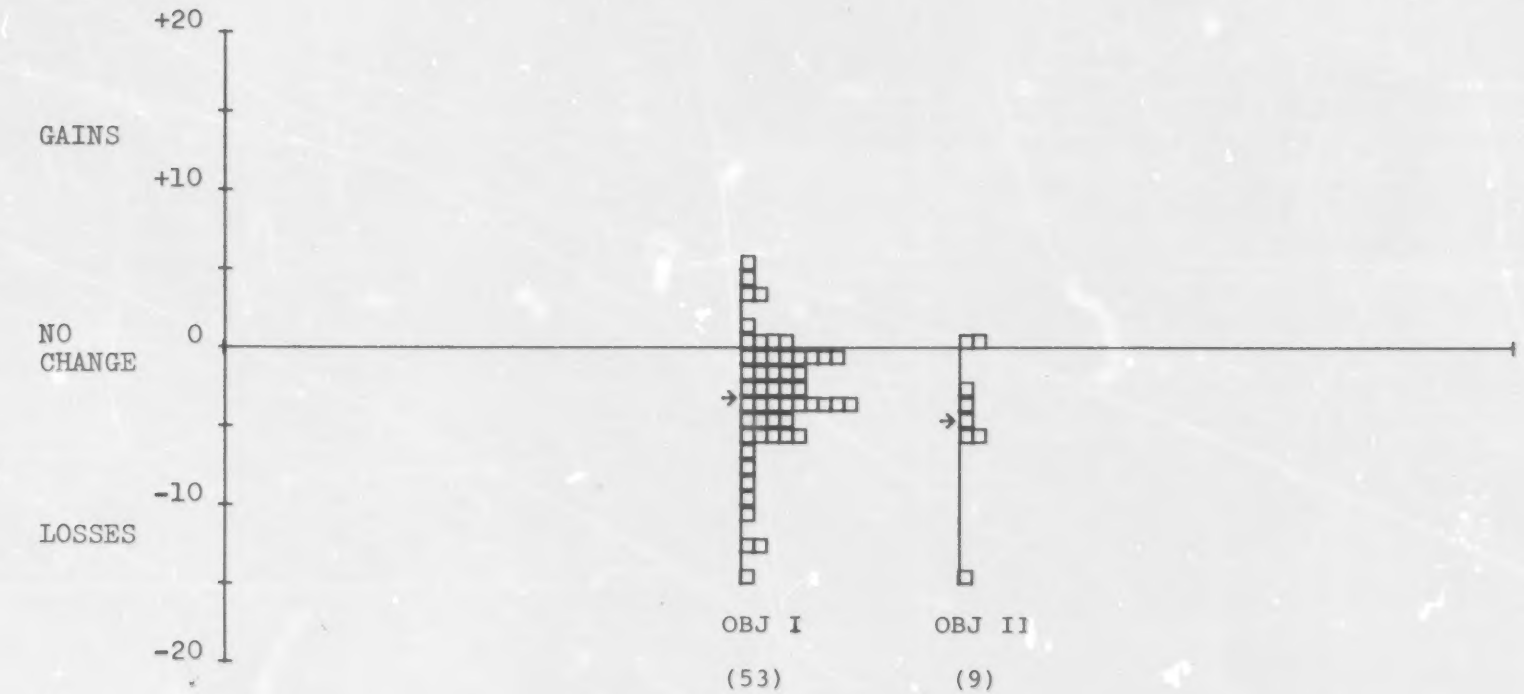
NAEP #	1969-70 Obj.	Type or Science	Description of Exercise	1969-70 National % Correct	1972-73 National % Correct	Change	Standard Error of Change
204106	II	P	A distillation flask, Bunsen burner & distillation condensor would be most useful to obtain pure water from salt water.	26.1	20.5	-5.6	(2.0)
101141	I	B	Text for this exercise was not released.				
204102	II	U	The fact that the center of Earth is a liquid is a model rather than an observation.	20.2	14.3	-5.9	(2.1)
101152	I	P	Light from the nearest star other than Sun needs about 5 yrs., not 1 week, 1 mo., 1 yr. or 100 yrs. to reach Earth.	56.2	50.2	-5.9	(2.2)
201076	I	P	Text for this exercise was not released.	17.2	10.4	-6.8	(1.3)
201023	III	U	Text for this exercise was not released.				
201073	I	P	A balloon filled with air has the same mass, not size, weight, rate of fall or ability to float on the moon as on Earth.	46.2	38.8	-7.5	(2.3)
101132	I	B	Text for this exercise was not released.	34.6	25.8	-8.8	(2.2)
102023	I	P	The length of time required for a pendulum bob to make one complete swing depends on the length of the pendulum string.	35.6	26.8	-8.9	(1.9)
101138	I	P	Chemistry is a study principally concerned with the properties of matter, not acids, actions, living things or energy.	88.4	79.3	-9.2	(1.4)
101137	I	P	One example of oxidation is the burning of wood in air, not neutralizing an acid or forming ice from water.	61.5	51.1	-10.4	(2.0)
204109	II	P	Describe a way to test whether or not it pays to buy premium gasoline for a secondhand car.	57.9	45.7	-12.2	(2.1)
101139	I	P	A transformer, not alternator, battery or rectifier is the device for changing the voltage of an electric power supply.	68.6	56.1	-12.4	(2.0)
				49.0	35.0	-14.1	(2.2)
				61.4	47.1	-14.3	(2.1)

EXHIBIT 11. Changes in Science Achievement by Type of Science for 17-Year-Olds Enrolled in School, 1969-73

Each box -- 1% high -- represents the change in performance on one science exercise.

Arrows indicate the mean change: -4.0 percentage points for physical science, -1.6 for biological science and -3.7 for unclassified exercises.

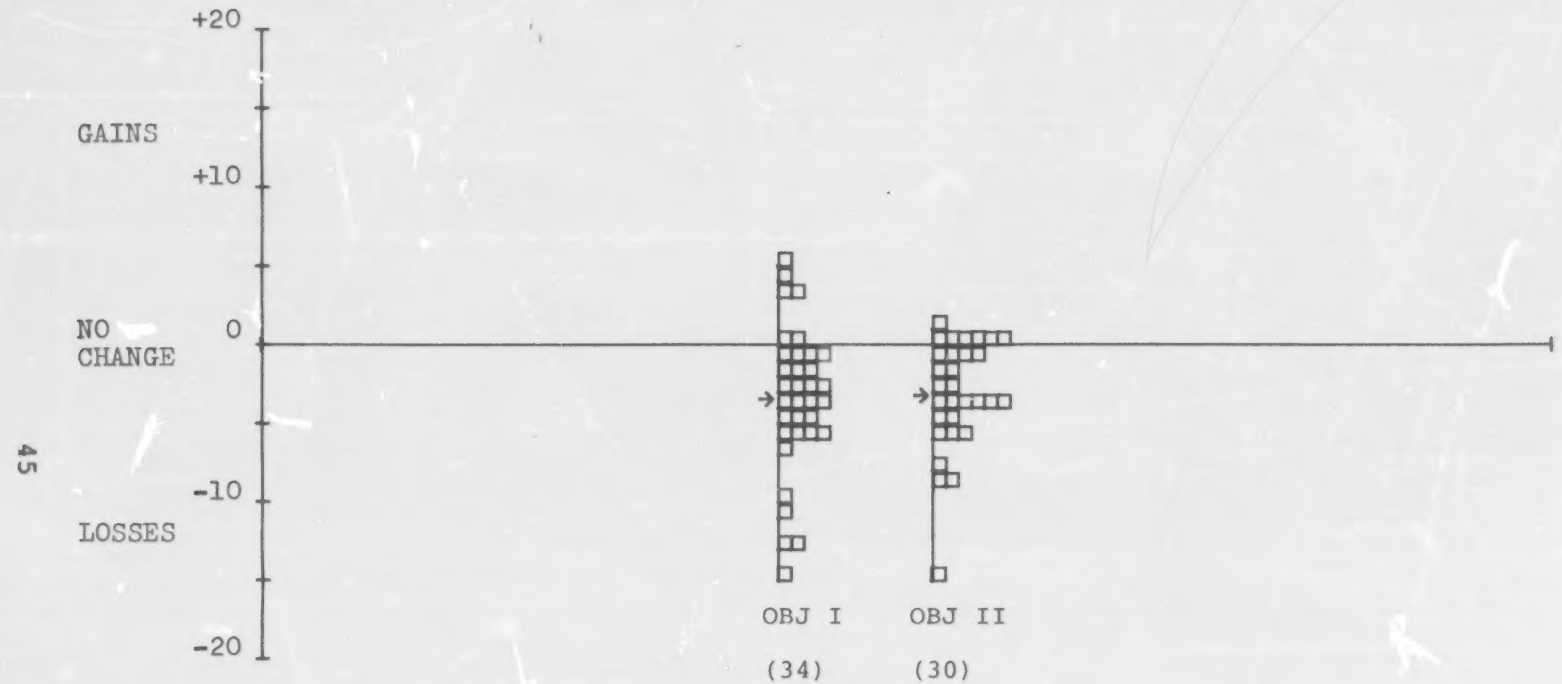
EXHIBIT 12. Changes in Science Achievement by 1969-70 Objectives for 17-Year-Olds Enrolled in School, 1969-73



Each box -- 1% high -- represents the change in performance on one science exercise.

Arrows indicate the mean change: -3.1 percentage points for Objective I and -4.5 for Objective II. Objective III, with only three exercises, is not displayed.

EXHIBIT 13. Changes in Science Achievement by 1972-73 Objectives for 17-Year-Olds Enrolled in School, 1969-73



Each box -- 1% high -- represents the change in performance on one science exercise.
Arrows indicate the mean change: -3.4 percentage points for Objective I and -3.1 for Objective II.

Summary of the National Changes

Knowledge, understanding and application of fundamental scientific facts and principles as measured by National Assessment exercises generally declined among American students aged 9, 13 and 17 between 1969 and 1970. A comparison of the 1969-70 national science assessment results with those of 1972-73 indicated that 9-year-olds, 13-year-olds and 17-year-olds enrolled in school in 1972-73 tended not to perform as well as these same age levels three to four years before.

At all three ages there was an average drop of 2-3% in the percentage of students who could correctly respond to a typical science question. Projecting these findings to an estimated 3.5 million students at each age, these declines indicate that:

1. Approximately 59,500 fewer 9-year-olds nationally could answer a typical National Assessment science question correctly in 1973 than could do so in 1970.

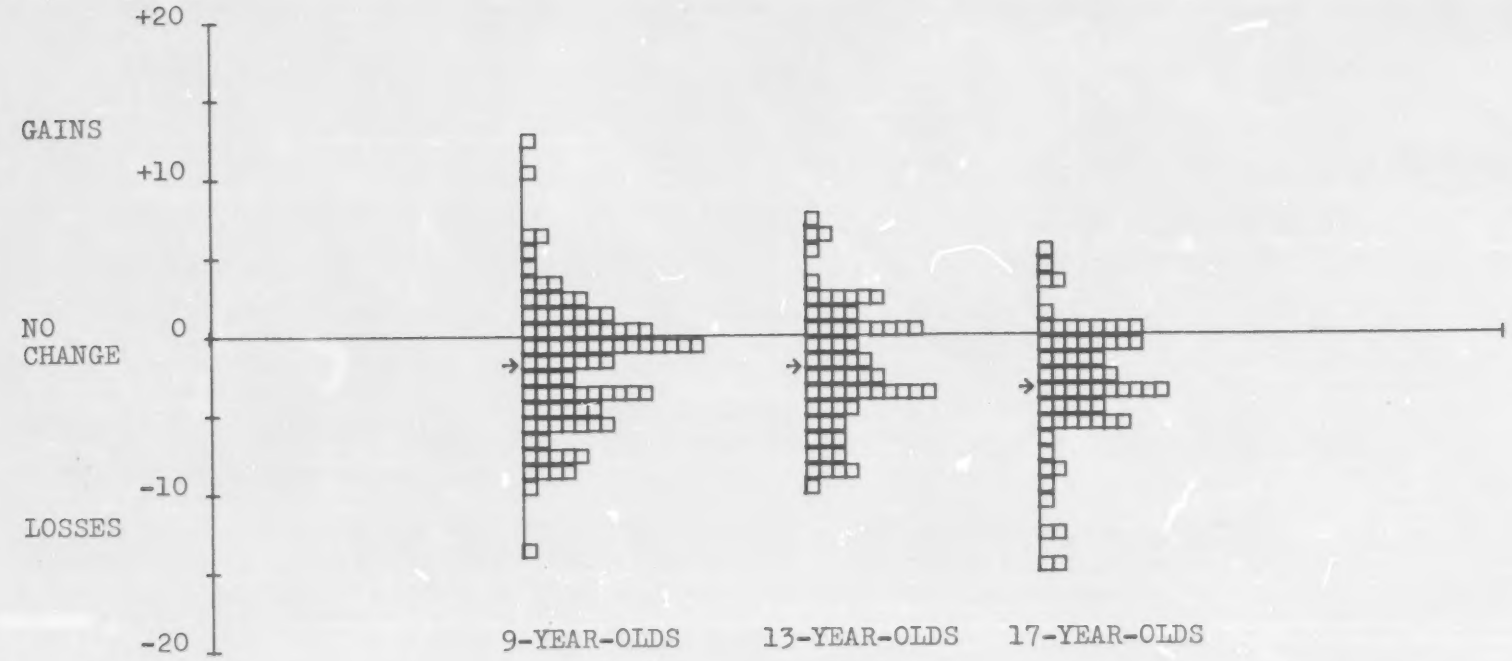
2. Approximately 66,500 fewer 13-year-olds could respond correctly to a typical National Assessment science question in 1972 than in 1969.

3. Approximately 112,000 fewer 17-year-olds could answer a typical National Assessment science question correctly in 1973 than in 1969.

The declines in performance tended to persist regardless of the type of science assessed or the objective covered.

Exhibit 14 summarizes the changes in performance for all three school-age groups.

EXHIBIT 14. Changes in Science Achievement, 1969-73



Each box -- 1% high -- represents the change in performance on one science exercise.
Arrows indicate the mean change: -1.7 at age 9, -1.9 at age 13 and -3.2 at age 17.

CHAPTER 3

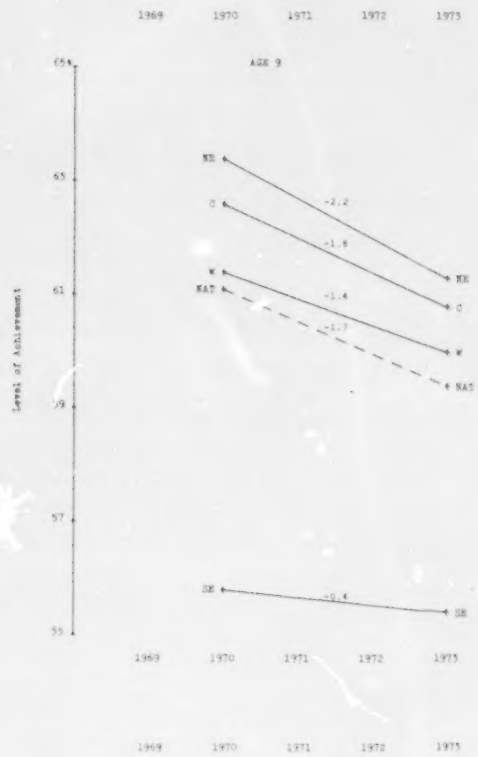
DIFFERENCES AMONG REGIONS

National Assessment respondents are divided into four regions based on where they live: Northeast, Southeast, Central or West.

When the respondents were classified by these four regions and the performance of the 1972-73 respondents was compared to that of the 1969-70 respondents, all regions except the Southeast showed general declines in achievement that paralleled the national declines (see Exhibit 15 and Appendix B). The performance of the Southeastern students dropped less than the national performance at ages 9 and 17 and actually improved at age 13. Although the Southeast had the lowest performance level of any region in both assessments, its position relative to the nation improved at all three ages from 1969 to 1973.

In the next three sections, we look at regional differences for each age and note how these changed from 1969 to 1973.

EXHIBIT 15. Average Changes in Performance for Regions at Ages 9, 13 and 17

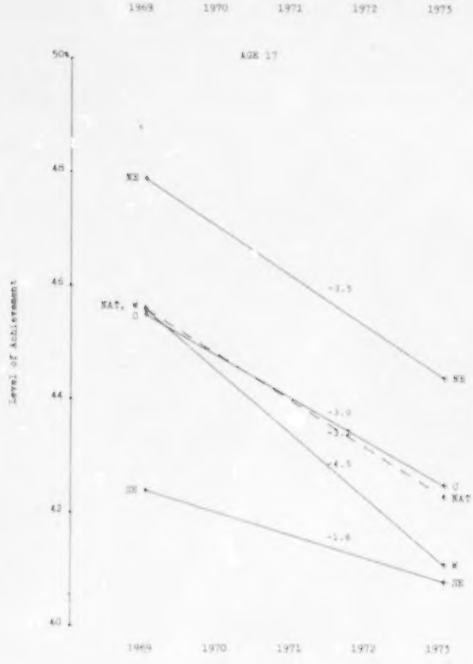


The Southeast did not decline as much as the nation at age 9.

Southeast performance improved at age 13 between 1969 and 1972

NAT = Nation
NE = Northeast
SE = Southeast
C = Central
W = West

EXHIBIT 15 (cont.). Average Changes in Performance for Regions at Ages 9, 13 and 17



The Southeast showed a smaller average decline than the nation at age 17.

NAT = Nation
NE = Northeast
SE = Southeast
C = Central
W = West

Age 9

The Northeastern 9-year-olds posted the highest relative performance in the first assessment of science, with an average 2.3 percentage points above the national average (see Table 6). The Southeast had the lowest relative performance, an average 5.4 percentage points below the nation. The Central and Western groups fell between these two extremes. In the second assessment, the Northeast again had the highest relative performance, although its advantage slipped to 1.8 percentage points. The Southeast again was lowest, but the gap between national and Southeastern 9-year-olds was reduced to 4.1 percentage points in the second assessment. Thus, the extreme groups were not quite as extreme in the second assessment, and the Southeast appeared to be closing the gap between its performance and that of the nation.

TABLE 6. Mean Differences Between Regions and the Nation, Ages 9, 13 and 17

	Mean Category Difference*					
Age 9 (92 Exercises)	1970	Standard Error	1973	Standard Error	Change Mean	Change Standard Error
Northeast	2.3	(0.5)	1.8	(0.6)	-0.5	(0.8)
Southeast	-5.4	(0.7)	-4.1	(0.9)	1.3	(1.1)
Central	1.5	(0.6)	1.4	(0.8)	-0.1	(1.0)
West	0.2	(0.7)	0.6	(0.8)	0.3	(1.1)
Age 13 (67 Exercises)	1969	Standard Error	1972	Standard Error	Mean	Standard Error
Northeast	1.8	(0.7)	2.4	(0.8)	0.5	(1.0)
Southeast	-5.1	(0.9)	-2.9	(0.9)	2.2	(1.3)
Central	2.4	(0.6)	1.6	(0.8)	-0.9	(1.0)
West	-0.4	(0.6)	-1.4	(0.8)	-1.0	(1.0)
Age 17 (64 Exercises)	1969	Standard Error	1973	Standard Error	Mean	Standard Error
Northeast	2.3	(0.6)	2.0	(0.5)	-0.3	(0.8)
Southeast	-3.2	(0.6)	-1.6	(0.6)	1.7	(0.8)
Central	-0.1	(0.5)	0.2	(0.6)	0.3	(0.8)
West	0.0	(0.5)	-1.2	(0.6)	-1.2	(0.8)

**Differences were obtained by subtracting the national percentage correct from the regional percentage correct. A positive-mean category difference indicates average performance for respondents in that category was above the national average. A negative-mean category difference indicates average category performance below the national average.*

Age 13

In the first assessment, the Central region showed the highest relative position for 13-year-olds (see Table 6). The Southeast showed the lowest position, at 5.1 percentage points below the nation, while the Western and Northeastern regions fell between these two extremes. In the second assessment, there was a change in the relative positions of the Central and Northeastern regions. In 1972 the Northeastern group had the highest relative position; its advantage increased from 1.8 percentage points in 1969 to 2.4 in 1972. The Central region slipped from its advantage of 2.4 percentage points in 1969 to 1.6 in 1972. The Southeast, although it remained the group with the lowest relative position, increased its relative position by an average of 2.2 percentage points, from -5.1 in 1969 to -2.9 in 1972. As with 9-year-olds, the 13-year-old Southeasterners' improved performance reduced the Southeast deficit.

Age 17

In the first assessment, the two extreme groups at age 17 were the Northeast, an average 2.3 percentage points above the nation, and the Southeast, an average 3.2 percentage points below the nation (see Table 6). These two groups were also the most extreme in the second assessment. The position of the Northeast remained fairly steady at an average of 2.0 percentage points above the nation in 1973. The Southeastern 17-year-olds narrowed the gap between their performance and that of the nation. In 1973 the average difference between the Southeast and the nation narrowed to 1.6 percentage points.

Summary for Ages 9, 13 and 17

While Northeastern, Central and Western average-performance levels followed national performance in declining at all three ages between 1969 and 1973, Southeastern performance remained about the same at ages 9 and 13 and showed a smaller decline than all other regions at age 17 (see Exhibit 15). Although there are no definitive answers for why this group showed such gains, it is interesting to note that from 1969-70 to 1972-73 the Southeast was quickly moving toward more integrated schools following several court decisions. Other regions did not move as quickly toward integration. This is more fully explored in the National Assessment report Racial and Regional Trends, 1969-1973.[1] This

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[1]See the inside covers of this report for ordering National Assessment reports from the Government Printing Office.

report presents regional changes in science achievement as well as the changing patterns in the racial compositions of schools.

CHAPTER 4

DIFFERENCES BETWEEN BOYS AND GIRLS

The performance of both boys and girls at all three ages declined at about the same rate as the nation as a whole. When the performance of 1970 9-year-old boys is compared to the performance of 1973 9-year-old boys, we find there was an average drop of 1.6 percentage points in correct responses. Girls similarly dropped 1.7 percentage points, while the national decline at age 9 was 1.7 percentage points. Boys' performance declined by an average of 1.9 percentage points at age 13; girls declined by 2.0. Nationally, 13-year-olds declined by 1.9 percentage points. Similarly, both sexes had similar declines at age 17: boys dropped 3.4 percentage points; girls, 3.0; and all 17-year-olds, 3.2 (Exhibit 16).

In addition, the average differences between boys and girls on the repeated science exercises remained fairly stable from 1969 to 1973, as the next section reveals.

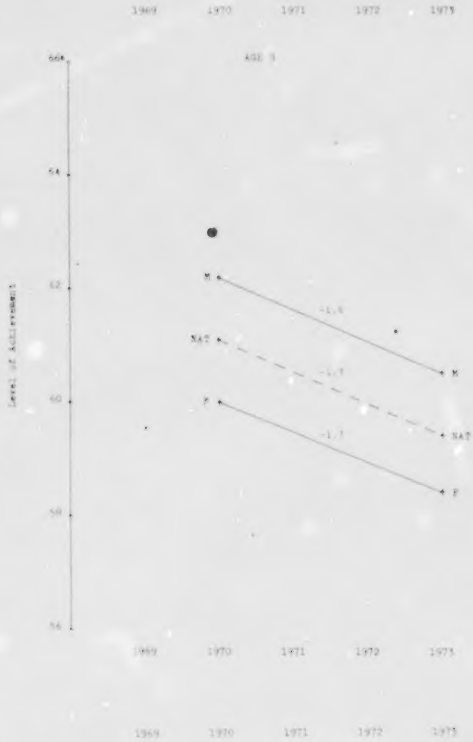
Age 9

In 1970, 9-year-old boys performed better than 9-year-old girls on the 92 repeated science questions by an average of 2.1 percentage points; that is, on these exercises, the percentage of boys correctly answering a typical science question in 1970 was 2.1 percentage points higher than that of girls (see Table 7). In 1973, boys again had the advantage with an average difference of 2.2 percentage points. Thus, boys performed slightly ahead of girls in both assessments of science.

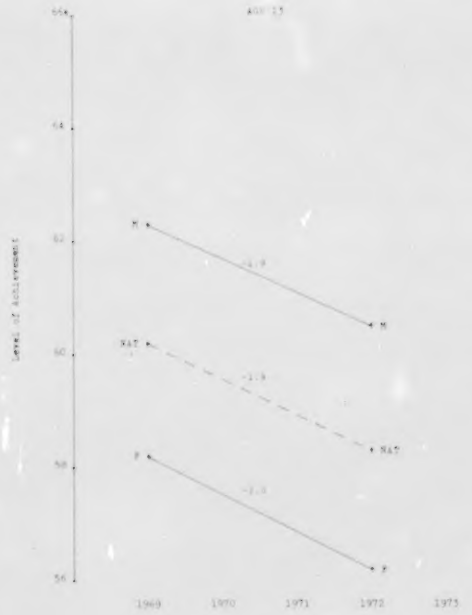
On 55 of the 92 repeated exercises, 9-year-old boys did better than 9-year-old girls in <u>both</u> assessments. Most of these were physical science exercises. On 18 exercises, the reverse occurred: girls did better than boys in both assessments. These exercises were mostly unclassified exercises. On the remainder of the exercises, the relative positions of boys and girls reversed between the two assessments. Table 8 lists some of the released exercises on which boys outperformed girls in both assessments and some on which girls did better in both assessments.

The boys' advantage was especially noticeable on physical science exercises. In 1970 the boys' advantage was 3.3 percentage

EXHIBIT 16. Average Changes in Performance for Males and Females at Ages 9, 13 and 17



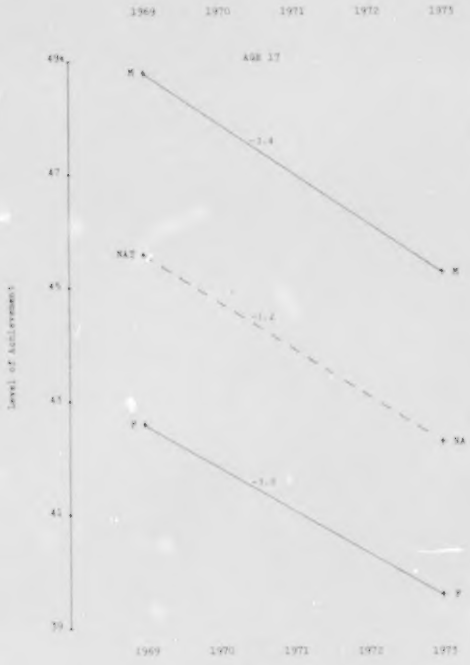
Nine-year-old boys slightly outperformed 9-year-old girls in both science assessments. The performance of both boys and girls dropped at about the same rate.



At age 13, boys continue to do better in science than girls although both showed average declines in performance.

NAT = Nation
M = Males
F = Females

EXHIBIT 16 (cont.). Average Changes in Performance for Males and Females at Ages 9, 13 and 17



The gap between boys and girls at age 17 is fairly large and remained stable from 1969 to 1973. Both sexes showed declines of the same magnitude.

NAT = Nation
M = Males
F = Females

TABLE 7. Mean Differences Between Boys and Girls, Ages 9, 13 and 17

Age 9	Number of Exercises	Mean Difference* 1970	Standard Error	1973	Standard Error
Total	9?	2.1	(0.6)	2.2	(0.7)
Physical science	5(	3.3	(0.7)	3.4	(0.7)
Biological science	27	1.8	(0.6)	1.6	(0.7)
Unclassified	15	-1.1	(0.9)	-0.7	(1.0)
Age 13		**1969**	**Standard Error**	**1972**	**Standard Error**
Total	67	4.2	(0.6)	4.3	(0.7)
Physical science	36	6.7	(0.7)	6.4	(0.8)
Biological science	23	1.2	(0.8)	2.6	(0.8)
Unclassified	8	1.5	(1.1)	-0.5	(1.0)
Age 17		**1969**	**Standard Error**	**1973**	**Standard Error**
Total	64	6.2	(0.5)	5.7	(0.6)
Physical science	39	9.0	(0.6)	8.7	(0.7)
Biological science	20	1.1	(0.7)	0.3	(0.9)
Unclassified	5	4.4	(1.2)	3.8	(1.3)

**Differences were obtained by subtracting the girls' percentage correct from the boys' percentage correct. A positive-mean difference favors boys' performance; a negative-mean difference favors girls' performance.*

points on physical science exercises. In 1973 the advantage was 3.4 percentage points. Although boys outperformed girls on biological exercises, their advantage was much smaller: 1.8 percentage points in 1970 and 1.6 in 1973. Only the unclassified exercises showed a slight but persistent advantage for girls: 1.1 percentage points in 1970 and 0.7 percentage points in 1973.

Age 13

The average gap between boys' and girls' science achievement jumped from 2 percentage points at age 9 to 4 percentage points at age 13 (see Table 7). In addition, this gap did not narrow between 1969 and 1973. In 1969, 13-year-old boys performed, on the average, 4.2 percentage points higher than girls; in 1972, this advantage was 4.3 percentage points. Thus, there was no change in the gap between boys and girls, and this gap increased from age 9 to 13.

TABLE 8. Released Exercises With Atypical Differences Between Boys and Girls, Age 9

NAEP #	1970 Diff.*	Standard Error	1973 Diff.*	Standard Error	Type of Science**	Description
A. Released exercises with a very large male advantage in both assessments.						
201056	9.8	(2.8)	12.8	(2.9)	P	Blowing on a campfire will speed up its burning, but covering it with sand, sprinkling dirt or water on it will not.
101099	8.8	(2.9)	9.3	(3.0)	P	Most of earth's surface is water, not cities and towns, farmland, solid rock or yellow.
101100	6.4	(2.8)	8.4	(2.4)	B	The bones and shells of sea animals that lived millions of years ago can be found in the rocks in the ground.
101064	5.6	(1.7)	4.3	(1.6)	B	Choose the penguin, not duck, sparrow or robin as the bird that CANNOT fly (pictures).
202106	5.5	(2.5)	5.2	(2.5)	P	Breaking a rock into three pieces does not change level of water in container holding rock.
B. Released exercises with a large female advantage in both assessments.						
105010	-7.3	(2.7)	-4.6	(2.6)	U	Scientists do not know everything about any topic.
101076	-6.1	(2.3)	-3.9	(2.6)	P	Electricity can be used for cooking food, heating homes and lighting rooms but not for taking walks.
204128	-4.3	(2.6)	-3.7	(2.2)	B	Read a doctor's chart to determine that younger people breathe faster than older people.

**Differences were obtained by subtracting the girls' percentage correct from the boys' percentage correct. A positive difference favors boys' performance; a negative difference favors girls' performance.*

***P = physical science, B = biological science and U = unclassified.*

Of the 67 exercises administered at age 13, boys performed better than girls on 45 exercises in both assessments; most of these were physical science exercises. On 13 of the exercises, girls did better than boys in both assessments. The majority of these were biological exercises. On the remaining 9 exercises, there were reversals in the relative performance of boys and girls. Table 9 lists some of the released exercises on which boys outperformed girls in both assessments and some on which girls outperformed boys in both assessments.

On the physical science exercises, the difference between boys and girls was 6.7 in 1969 and 6.4 in 1972. This gap is almost twice as large as the 3.4 percentage-point difference on physical science exercises at age 9. But on the biological exercises we find that the gap between boys and girls was still relatively small, as it was at age 9: 1.2 percentage points in 1969 and 2.6 percentage points in 1972. Although the differences on the biological exercises still favored boys, they did not increase with age or across years. Unclassified exercises showed a slight edge for boys in 1970 (1.5 percentage points) but a slight edge for girls in 1972 (0.5 percentage points).

Age 17

At this age the differences between boys and girls increased to an advantage of 6 percentage points for boys in 1969 and a 5.7 percentage-point advantage in 1973. Again, as at ages 9 and 13, the gap did not narrow between assessments but remained fairly constant (see Table 7).

The superior performance of boys was quite evident from the number of exercises on which boys outperformed girls in both assessments: 53 of the 64 repeated science exercises given to 17-year-olds fell into this category, and most of the 53 were physical science exercises. Only 5 exercises showed better performance by girls in both assessments; all 5 were biological science exercises. The remainder showed reversals in the performance of boys and girls from 1969 to 1973.

Table 10 lists released exercises with a very large male advantage in both assessments and those with a female advantage in both assessments. Of those listed, all the male-advantage exercises are physical science exercises; the female-advantage exercises are all biological and deal with the female reproductive cycle, with the rules of good nutrition and with medicine used in the treatment of diabetes.

Classifying these 64 repeated exercises by type of science, boys outperformed girls by 9.0 percentage points in 1969 and by 8.7 percentage points in 1973 on the physical science exercises,

TABLE 9. Released Exercises With Atypical Differences Between Boys and Girls, Age 13

NAEP #	1969 Diff.*	Standard Error	1972 Diff.*	Standard Error	Type of Science**	Description
A. Released exercises with a very large male advantage in both assessments.						
203023	24.7	(2.7)	20.6	(2.9)	P	If a ball is dropped on the sidewalk from a height of one yard, it could bounce 5/8 yard high.
101129	16.2	(3.3)	15.6	(3.2)	P	A compass can be used to find north on Earth because Earth has a magnetic field.
204092	15.1	(3.1)	14.0	(2.8)	P	If a stopper pops out of a heated tube, the best reason given is that some water has changed to steam.
204097	12.6	(2.8)	6.8	(3.1)	U	If 705 plants have red flowers and 224 have white, the ratio of red to white is about 3:1, not 700:1, 4:1, 2:1 or 1:480.
201086	10.9	(3.0)	7.4	(2.6)	P	Heat a quart of 70 degree water to 150 degrees, and the water level will be highest in the beaker with the long, thin neck.
201070	8.6	(3.2)	8.1	(2.6)	P	A single atom of carbon cannot be seen directly by the human eye using an ordinary-light microscope or telescope.
102030	7.5	(3.0)	12.4	(2.6)	B	The density of the human body is most nearly equal to the density of water, not air, cork, hydrogen or iron.
101109	7.3	(2.5)	11.6	(2.4)	B	Green plants are important to man because they produce food and give off oxygen.
B. Released exercises with a larger female advantage in both assessments.						

TABLE 9 (cont.). Released Exercises With Atypical Differences Between Boys and Girls, Age 13

NAEP #	1969 Diff.*	Standard Error	1972 Diff.*	Standard Error	Type of Science**	Description
204095	-6.5	(2.4)	-5.4	(2.7)	B	That Siamese cats are prettier than other cats is an opinion rather than a fact about cats.
205021	-4.1	(2.5)	-6.1	(2.1)	U	A scientist is probably seeking relationships when he studies carefully the many measurements taken in an experiment.
101119	-1.9	(2.8)	-5.4	(2.3)	P	A powder of black and white specks is a mixture, not sugar, pepper, an element or a pure compound.

**Differences were obtained by subtracting the girls' percentage correct from the boys' percentage correct. A positive difference favors boys' performance; a negative difference favors girls' performance.*

***P = physical science, B = biological science and U = unclassified.*

TABLE 10. Released Exercises With Atypical Differences Between Boys and Girls, Age 17

NAEP #	1969 Diff.*	Standard Error	1973 Diff.*	Standard Error	Type of Science**	Description
A. Released exercises with a very large male advantage in both assessments.						
101142	23.3	(2.6)	19.2	(2.5)	P	If a sudden change took place on the surface of the Sun, it could first be observed on Earth after about 8 minutes.
204106	21.5	(2.8)	13.5	(2.3)	P	A distillation flask, Bunsen burner and distillation condensor would be most useful to obtain pure water from salt water.
101139	19.9	(3.1)	26.9	(2.5)	P	A transformer, not alternator, battery or rectifier is the device for changing the voltage of an electric power supply.
201073	18.0	(2.7)	15.3	(2.3)	P	A balloon filled with air has the same mass, not size, weight, rate of fall or ability to float on the Moon as on Earth.
202088	17.6	(2.4)	15.3	(2.4)	P	The spring balance nearest the weight will have a higher reading than the one farther away.
101138	14.6	(3.2)	11.7	(2.5)	P	Chemistry is a study principally concerned with the properties of matter, not acids, actions, living things or energy.
102023	14.0	(2.9)	10.9	(2.5)	P	The length of time required for a pendulum bob to make one complete swing depends on the length of the pendulum string.
204109	13.7	(3.3)	10.2	(2.5)	P	Describe a way to test whether or not it pays to buy premium gasoline for a secondhand car.

TABLE 10 (cont.). Released Exercises With Atypical Differences Between Boys and Girls, Age 17

NAEP #	1969 Diff.*	Standard Error	1973 Diff.*	Standard Error	Type of Science**	Description
101153	13.6	(2.8)	13.5	(2.9)	P	A refrigerator keeps its contents cool by transferring heat, not freshening food or destroying energy.
B. Released exercises with a large female advantage in both assessments.						
101148	-11.9	(2.6)	-13.4	(2.7)	B	On the average, in human females, the egg is released 14, not 2, 9 or 20 days after menstruation begins.
101134	-11.6	(3.5)	-17.8	(3.0)	B	The human embryo normally develops in the uterus, not the abdominal cavity, ovary, oviduct or vagina.
101135	-6.3	(2.9)	-6.3	(2.4)	B	Insulin, not estrogen, iodine, penicillin or thyroxine is used in the treatment of diabetes.
202092	-2.3	(0.7)	-1.7	(0.9)	B	A vegetable should be added to a meal of milk, bread and butter, meat and cake to satisfy the rules of good nutrition.

**Differences were obtained by subtracting the girls' percentage correct from the boys' percentage correct. A positive difference favors boys' performance; a negative difference favors girls' performance.*

***P = physical science, B = biological science and U = unclassified.*

2 to 3 points more than at age 13. But on the biological exercises the gap between boys and girls was still small: 1.1 percentage points in 1969 and 0.3 percentage points in 1973, both slightly favoring boys. The unclassified exercises also showed an advantage for boys in both years: 4.4 percentage points in 1969 and 3.8 percentage points in 1973.

Summary for Ages 9, 13 and 17

From 1969 to 1973, both boys and girls showed declines in science achievement that paralleled those seen nationally. But the differences between boys' and girls' science achievement remained remarkably steady from 1969 to 1973. In both assessments, boys outperformed girls by an average of 2 percentage points at age 9, 4 at age 13 and 6 at age 17. On physical science exercises, the boys' advantage increased even more dramatically with age: 3 percentage points at age 9, 6-7 at age 13 and 9 at age 17. On biological science exercises, boys held a slight edge at all three ages, but the magnitude of this advantage was small and did not increase with age. Exhibits 17, 18 and 19 depict these differences by type of science for each age.

The gaps, which tended to persist from 1969 to 1973 on all types of science exercises, between the performance of boys and girls on all science exercises are also graphed in Exhibits 20 and 21. In 1969-70 as in 1972-73, boys performed much better than girls on physical science exercises and just slightly better on biological exercises. Exhibits 20 and 21 graphically show how these differences increased with age, even though different exercises were given to each age.

EXHIBIT 17. Average Difference Between Boys and Girls on Science-Change Exercises, Age 9

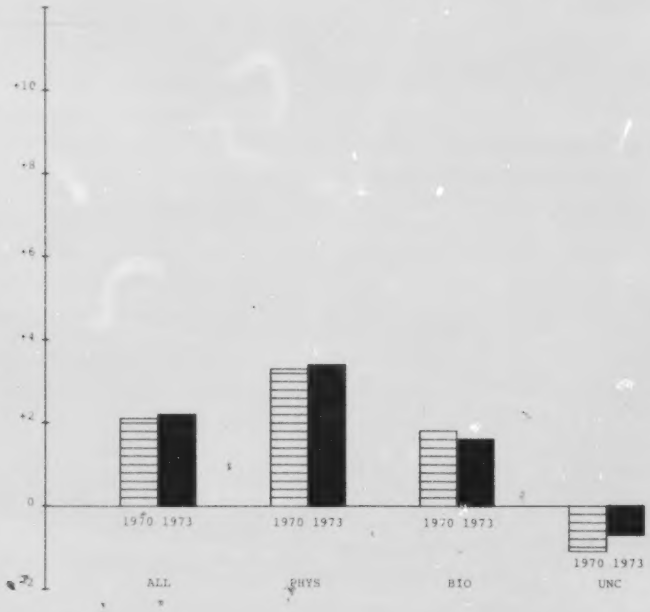


EXHIBIT 18. Average Difference Between Boys and Girls on Science-Change Exercises, Age 13

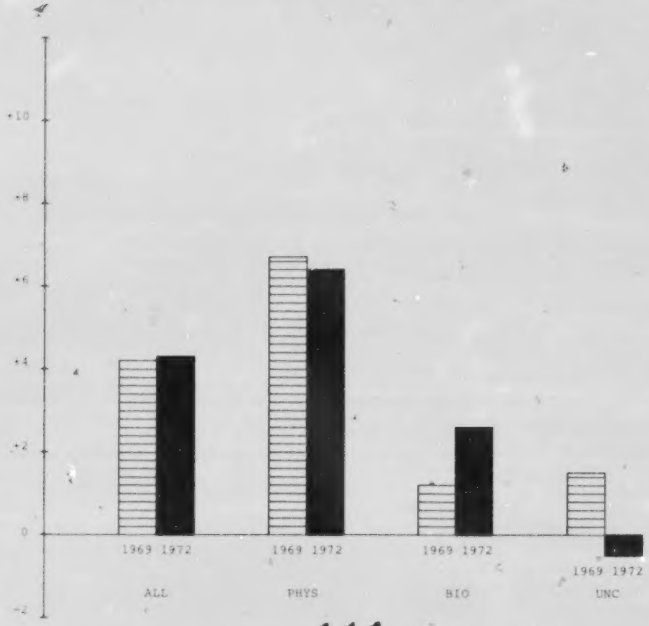


EXHIBIT 19. Average Difference Between Boys and Girls on Science-Change Exercises, Age 17

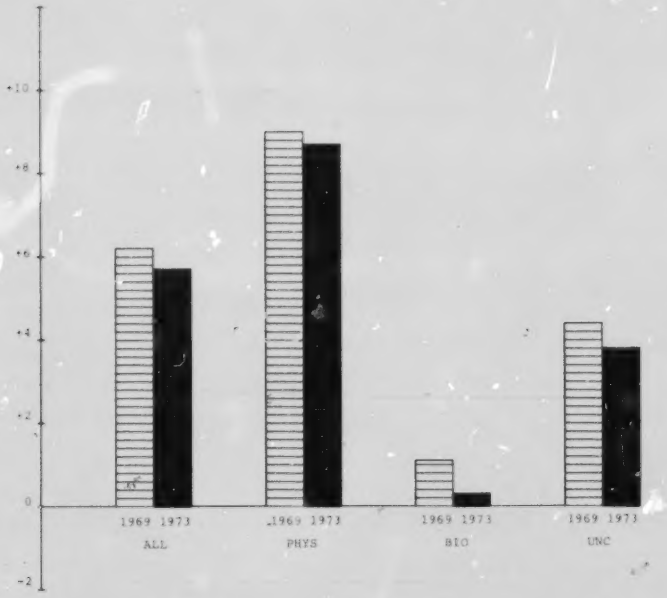
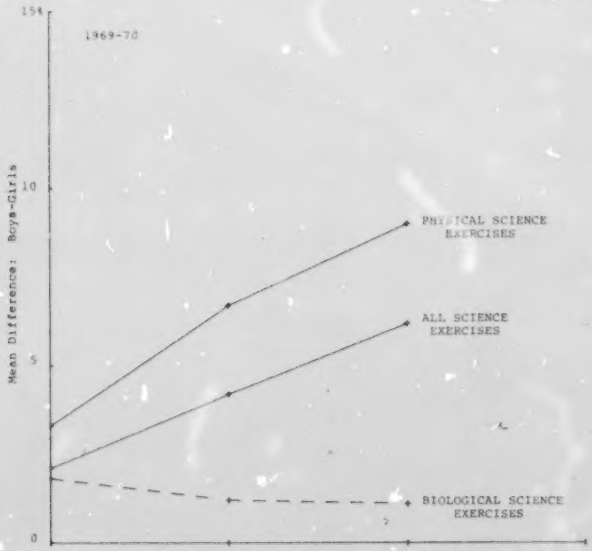
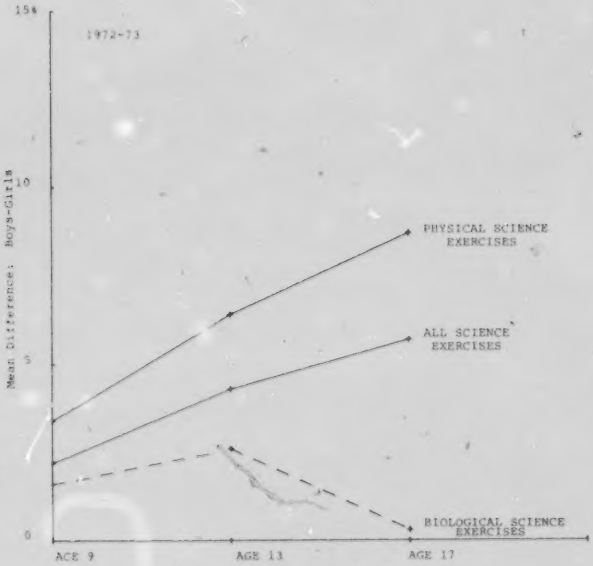


EXHIBIT 20. Average Differences Between Boys and Girls on Physical and Biological Science Exercises, 1969-70



# of Exercises	Age 9	Age 13	Age 17
All	92	67	64
Physical	50	36	39
Biological	27	23	20

EXHIBIT 21. Average Differences Between Boys and Girls on Physical and Biological Science Exercises, 1972-73



# of Exercises	Age 9	Age 13	Age 17
All	92	67	64
Physical	50	36	39
Biological	27	23	20

CHAPTER 5

DIFFERENCES BETWEEN BLACKS AND WHITES

In both assessments, respondents were classified into three racial categories: whites, blacks or others.[1] Since the percentage of respondents classified as "other" was extremely small (about 5-7% of the respondents, as shown in Appendix A), change data are reported only for blacks and whites.

Both blacks and whites showed average declines in performance closely paralleling the declines seen in the nation as a whole (see Exhibit 22 and Appendix B).[2] At age 9, black performance declined an average of 0.9 percentage points, slightly less than the nation, while white performance declined an average 1.5 percentage points. The decline at age 13 was an average 3.2 percentage points for blacks and 1.7 for whites. Seventeen-year-old blacks declined 1.9 percentage points and whites 2.7 percentage points. Although both blacks and whites showed average downward changes in performance, black performance did not decline as much as white performance at ages 9 and 17 but declined more than whites at age 13. However, in each assessment year and at every age there was a rather large difference in the performance of these two groups.

Age 9

In 1970 the average differences between black and white 9-year-olds was 17.1 percentage points in favor of whites; that is, on an average repeated science exercise, the performance of whites

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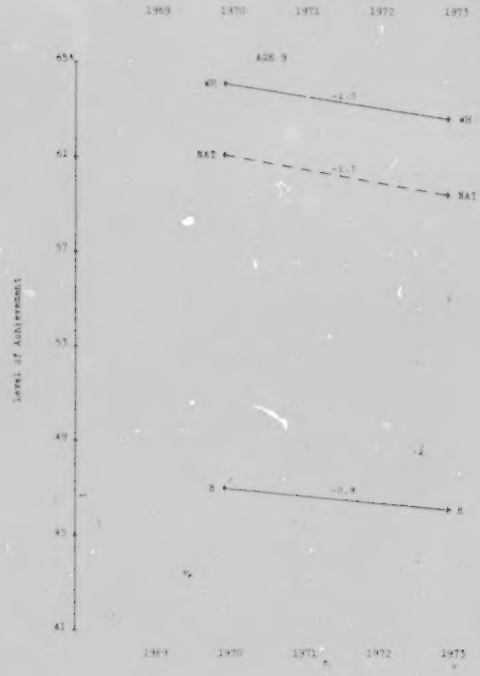
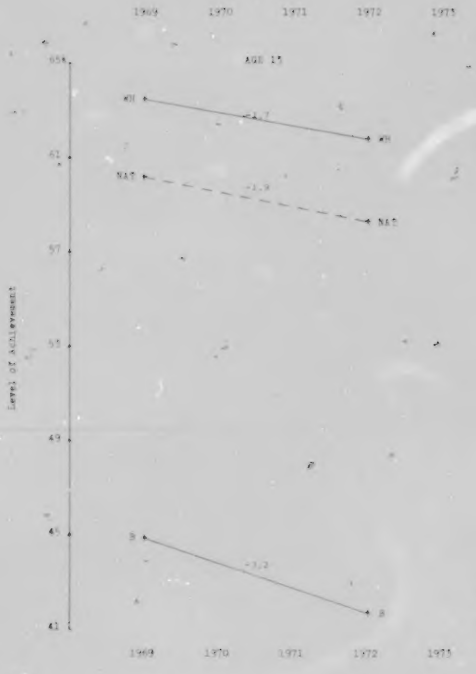
[1]See Appendix A for information on how respondents were classified into the three racial categories in each assessment year.

[2]Additional information on the changes in science achievement of racial categories can be found in the National Assessment report Science Achievement: Racial and Regional Trends, 1969-1973 (see inside covers of this report for ordering National Assessment reports from the Government Printing Office). Additional results for black students can be found in J. M. Sauls and J. M. Kalk, "Changes in Science Achievement of Black Students," paper presented at American Educational Research Association, San Francisco, April 1976. This paper looks at the changes in science achievement for blacks classified by region, sex, and size and type of community.

EXHIBIT 22. Average Changes in Performance for Blacks and Whites at Ages 9, 13 and 17



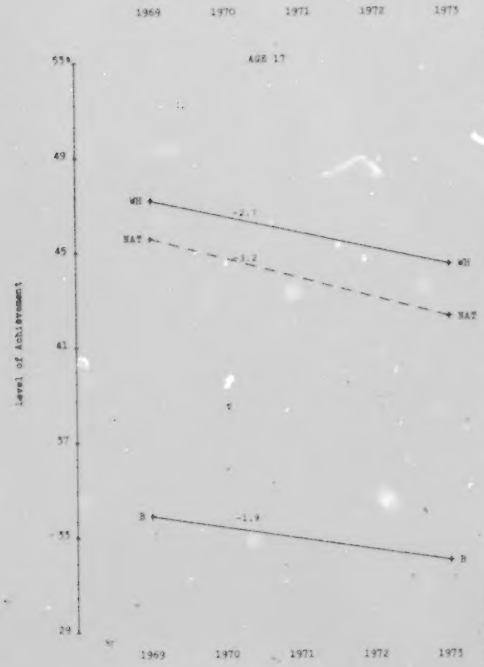
The gap between the performance of black and white 9-year-olds remained the same between 1970 and 1973.



At age 13 the gap increased slightly, since black 13-year-olds showed a slightly larger decline than the nation.

NAT = Nation
WH = White
B = Black

EXHIBIT 22 (cont.). Average Changes in Performance for Blacks and Whites at Ages 9, 13 and 17



The gap between the performance of black and white 17-year-olds remained about the same between 1969 and 1973.

NAT = Nation
WH = White
B = Black

was 17.1 percentage points higher than that of blacks. In 1973 there was a similar gap between these two races; the average difference was 16.5 percentage points in 1973, again in favor of white respondents. Average differences between blacks and whites remained large (14-17 percentage points in favor of whites) regardless of the type of science assessed (see Table 11).

TABLE 11. Mean Differences Between Blacks and Whites, Ages 9, 13 and 17

		Mean Difference*			
Age 9	Number of Exercises	1970	Standard Error	1973	Standard Error
Total	92	17.1	(0.9)	16.5	(0.6)
Physical science	50	17.5	(1.0)	17.5	(0.8)
Biological science	27	16.8	(1.2)	14.4	(0.7)
Unclassified	15	16.5	(1.3)	16.8	(1.1)
Age 13		1969	Standard Error	1972	Standard Error
Total	67	18.6	(0.7)	20.1	(0.7)
Physical science	36	19.0	(0.9)	20.8	(0.8)
Biological science	23	18.4	(0.8)	19.6	(1.0)
Unclassified	8	17.4	(1.3)	18.7	(1.3)
Age 17		1969	Standard Error	1973	Standard Error
Total	64	13.2	(0.7)	12.5	(0.7)
Physical science	39	12.9	(0.9)	12.6	(0.9)
Biological science	20	13.1	(1.2)	12.4	(1.1)
Unclassified	5	16.6	(1.4)	11.7	(1.7)

*Differences were obtained by subtracting the black percentage correct from the white percentage correct. A positive mean indicates that, on the average, whites are performing better than blacks.

Whites performed better than blacks on 85 of the 92 repeated exercises. Some of these exercises had extremely large differences (greater than 30 percentage points) in both assessments, some of which are listed in Table 12. On the other 7 exercises, blacks performed better than whites in at least one assessment. The three exercises on which blacks did better than whites in both assessments are listed in Table 12.

TABLE 12. Released Exercises With Atypical Differences Between Blacks and Whites, Age 9

NAEP #	1970 Diff.*	Standard Error	1973 Diff.*	Standard Error	Type of Science**	Description
A. Released exercises with a very large white advantage in both assessments.						
101076	37.8	(3.8)	34.9	(3.5)	P	Electricity can be used for cooking food, heating homes and lighting rooms but not for taking walks.
204084	33.8	(3.6)	30.5	(3.6)	P	Classify a cloud at 10,000 feet as a middle cloud instead of high or low using a specific scheme given.
204091	32.8	(3.9)	30.4	(4.2)	B	To know how much a person grew in one year, you must know his height at the beginning of the year.
202081	32.3	(5.3)	38.6	(2.7)	P	One pint is the space a rock needs if the water level rises from five to six pints when the rock is added.
204077	30.4	(2.3)	33.1	(3.1)	P	It is easier to measure the length of a pencil with a 12-inch ruler than thickness of paper or distance from home.
B. Released exercises with a black advantage in both assessments.						
201085	-4.2	(2.5)	-5.4	(1.8)	P	To find the air temperature outdoors, it would be best to put the thermometer in the shade.
1-1085	-2.7	(3.1)	-1.3	(2.0)	B	Helping to cool your body is the main way sweating helps it.
201067	-1.5	(2.3)	-2.2	(1.6)	P	A pint of water 50 degrees Fahrenheit mixed with a pint of water 70 degrees Fahrenheit yields water that is ABOUT 60 degrees Fahrenheit.

**Differences were obtained by subtracting the black percentage correct from the white percentage correct. A positive difference favors whites; a negative difference favors blacks.*

***P = physical science, B = biological science and U = unclassified.*

Age 13

The gap between white and black performance was also large at age 13. The average difference between white and black performance was 18.6 percentage points in 1969 and 20.1 percentage points in 1972. These gaps persisted on all three types of science exercises (see Table 11).

On 64 of the 67 repeated exercises, whites outperformed blacks. Table 13 lists some of these exercises where the differences were extremely large in both assessments (larger than 30 percentage points). Two exercises showed a black advantage in both assessments. Only one was released and it is listed in Table 13. The one unreleased exercise showed a black advantage of 1.4 percentage points in 1969 and 1.8 percentage points in 1972.

Age 17

The gap between whites and blacks was smallest for in-school 17-year-olds, although the average difference clearly favored white performance in both assessments. In 1969 the average difference was 13.2 percentage points and 12.5 percentage points in 1973. When the exercises were classified by type of science, there was a noticeable narrowing of black/white differences on the five unclassified exercises: from 16.6 percentage points in 1969 to 11.7 percentage points in 1973. The differences between blacks and whites on the physical and biological exercises remained at about 12-13 percentage points in both assessments.

Most of the repeated exercises (54 out of 64) showed whites outperforming blacks in both assessments. A few exercises with a very large white advantage in both years are listed in Table 14. Three of the four exercises with a black advantage in both years were released and are listed in Table 14. The most remarkable exercise is 204075 on which blacks outperformed whites by a margin of 22 percentage points in the first assessment. Although this edge dropped to about 9 percentage points in the second assessment, this is clearly an exercise where blacks demonstrated more correct information than whites. This particular exercise asked respondents to correctly identify a graph of the relationship between the pressure of a gas and its volume.

Summary for Ages 9, 13 and 17

In general, both blacks and whites tended not to perform as well in the second assessment as they did in the first. In addition, the gap between black and white performance remained very large: whites outperformed blacks by about 17 percentage points in both assessments at age 9, by about 19-20 percentage points at

TABLE 13. Released Exercises With Atypical Differences Between Blacks and Whites, Age 13

NAEP #	1969 Diff.*	Standard Error	1972 Diff.*	Standard Error	Type of Science**	Description
A. Released exercises with a very large white advantage in both assessments.						
204097	36.2	(2.9)	31.5	(2.8)	U	If 705 plants have red flowers and 224 have white, the ratio of red to white is about 3:1.
201072	35.0	(3.0)	35.1	(3.0)	P	Fanning makes a fire burn better because fanning increases oxygen supply.
101129	34.1	(4.5)	36.8	(3.3)	P	A compass can be used to find north on Earth because Earth has a magnetic field.
204095	31.0	(4.1)	38.7	(3.4)	B	That Siamese cats are prettier than other cats is an opinion rather than a fact about cats.
B. Released exercises with a black advantage in both assessments.						
101123	-2.8	(1.9)	-9.1	(2.1)	P	Water vapor, not oxygen, nitrogen, hydrogen gas or carbon atoms in crystal form, is formed when a candle burns.

Differences were obtained by subtracting the black percentage correct from the white percentage correct. A positive difference favors whites; a negative difference favors blacks.

**P = physical science, B = biological science and U = unclassified.*

TABLE 14. Released Exercises With Atypical Differences Between Blacks and Whites, Age 17

NAEP #	1969 Diff.*	Standard Error	1973 Diff.*	Standard Error	Type of Science**	Description
A. Released exercises with a very large white advantage in both assessments.						
101116	35.4	(3.8)	37.1	(2.8)	B	Of the listed choices, cancer is best described as uncontrolled cell division.
201079	31.0	(4.8)	20.5	(3.1)	P	In hot climates, the advantage of buildings with white surfaces is that they reflect, not absorb or refract light.
204109	30.0	(4.0)	29.4	(2.4)	P	Describe a way to test whether or not it pays to buy premium gasoline for a secondhand car.
101135	25.5	(5.1)	25.9	(3.5)	B	Insulin, not estrogen, iodine, penicillin or thyroxine is used in the treatment of diabetes.
B. Released exercises with a black advantage in both assessments.						
204075	-22.0	(5.2)	-8.6	(2.0)	P	The graph with the negative exponential shows how the pressure of a gas sample changes as its volume changes.
202090	-0.2	(1.4)	-0.8	(1.2)	P	During electrolysis, 1.0 faraday of electrons can produce 1.0 gram-atom of Ag from $AgNO_3$ solution.
101147	-0.1	(1.2)	-2.2	(1.2)	P	Metal cans for holding foodstuffs are chiefly made of iron, not copper, nickel or tin.

**Differences were obtained by subtracting the black percentage correct from the white percentage correct. A positive difference favors whites; a negative difference favors blacks.*

***P = physical science, B = biological science and U = unclassified.*

age 13 and by about 13 percentage points at age 17. The gaps also tended to persist regardless of the type of science assessed. Only a few exercises at each age showed blacks outperforming whites, most of which showed a very small black advantage.

A Final Note

As with any testing program, National Assessment must be alert to the possibility of cultural bias in exercises that may unduly help or hinder the achievement results of some particular category of respondents. Although these repeated science questions were reviewed extensively for offensiveness and appropriateness as well as for technical considerations by science experts, educators and other people from a variety of backgrounds, it may be possible that some of these exercises may unduly hinder or help the achievement of certain groups of respondents. The testing situation itself (paper and pencil) may also be a hindrance to the performance of some categories of students, although it is not known how much this might contribute to the low performance of blacks. Reading difficulties are alleviated to some extent in the national assessments since each exercise is read aloud to the students from a tape using a nonregional speaking voice. The possible causes for the large white/black differences and why they persisted between 1969 and 1973 should be explored further.

CHAPTER 6

DIFFERENCES AMONG SIZE-AND-TYPE-OF-COMMUNITY CATEGORIES

The size-and-type-of-community (STOC) categories are defined by the size of the community in which a student's school is located and by an occupational profile of the area the school serves, as indicated by the school principal. Three of the categories are "extremes": extreme rural, low metro and high metro. Each of these categories represents the most extreme 10% of the respondents at each age level. The extreme-rural category is comprised of students attending schools in rural areas where a high proportion of adults are farm workers and a low proportion are professional, managerial or factory workers. Similarly, the low-metro category is comprised of all those respondents who attend schools in city areas where a high proportion of the adult population is either not regularly employed or on welfare and a low proportion is employed in professional or managerial positions. The third extreme category, high metro, is comprised of respondents attending schools in city and near-city areas where a high proportion of adults are employed in professional or managerial positions and a low proportion are factory or farm workers, not regularly employed or on welfare. The remaining respondents are classified into the four other STOC categories based on size of community in which the school is located:

1. Main big city. Schools in this group are located in big cities of population greater than 200,000 but not included in either the low-metro or high-metro categories.

2. Urban fringe. These schools are in the urbanized areas of big cities of size greater than 200,000 and not included in either the low-metro or high-metro categories.

3. Medium city. These schools are in cities with population between 25,000 and 200,000 that are not urbanized areas of big cities.

4. Small places. Schools in this category are located in open country or are from places with populations of less than 25,000, not including those in the extreme-rural category.

Although the definitions of the STOC categories have remained the same between the two assessments and the size of communities were held constant by using 1970 Census data in both assessments, the compositions or characteristics of these categories may have changed. Schools classified as extreme rural in one year may not be classified as extreme rural in the next assessment due to population shifts or the consolidation of schools. Changes in this chapter are reported for STOC categories, regardless of the changes that might have occurred naturally to these categories over time.

Most of the STOC categories showed a lower average performance in the second assessment at all three ages. The only notable exception was the extreme-rural category: at ages 9 and 13 their average performance was higher in the second assessment, instead of lower, and at age 17 the decline for the extreme rural was the smallest of any of the STOC categories and well above the decline seen for all 17-year-olds. Thus, although all of the other six STOC categories showed average declines in science achievement at all three ages, the average performance in the extreme-rural category declined at a slower rate than the nation at age 17 and actually improved at ages 9 and 13. These changes are pictured in Exhibit 23.

In the next section we look at the relative positions of these categories and how they have changed from the first to the second assessment.

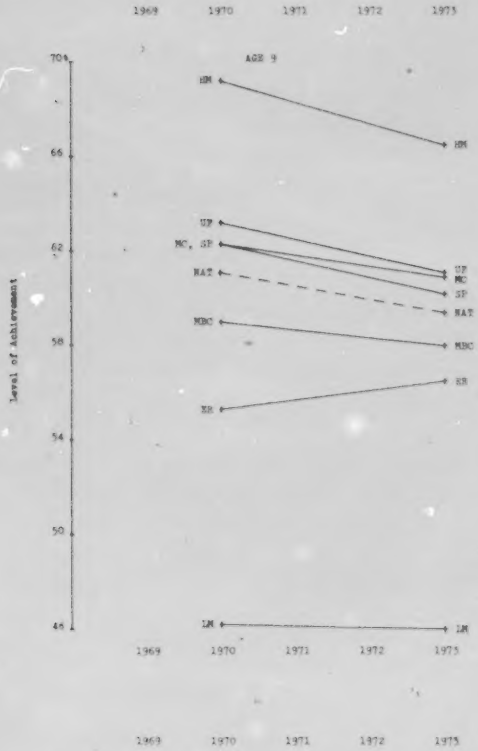
Age 9

Most of the STOC groups at age 9 maintained their relative positions and the changes were all fairly small. The highest and lowest performing 9-year-old STOC categories remained the same in both assessments, as seen in Table 15. The high-metro category had the highest relative position in both years: an average of 8.1 percentage points above the nation in 1970 and 7.1 in 1973. The low-metro category remained the lowest: an average of 14.9 percentage points below in 1970 and 13.4 below in 1973. The one exception was the extreme-rural category, which improved its relative position by an average of 2.9 percentage points, from an average of 5.9 percentage points below the nation in 1970 to 3.0 below in 1973.

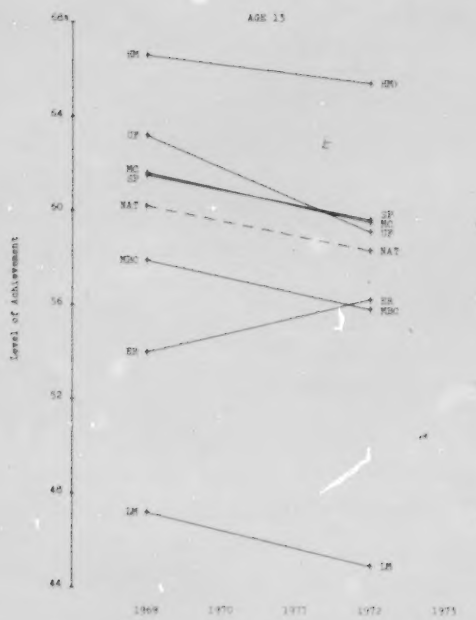
Age 13

In both assessments the high-metro 13-year-olds outperformed all other size-and-type-of-community categories. Their average advantage over all 13-year-olds was 6.4 percentage points in 1969 and 7.1 in 1972. The low-metro category was the lowest in both

EXHIBIT 23. Average Changes in Performance for Size-and-Type-of-Community Categories at Ages 9, 13 and 17



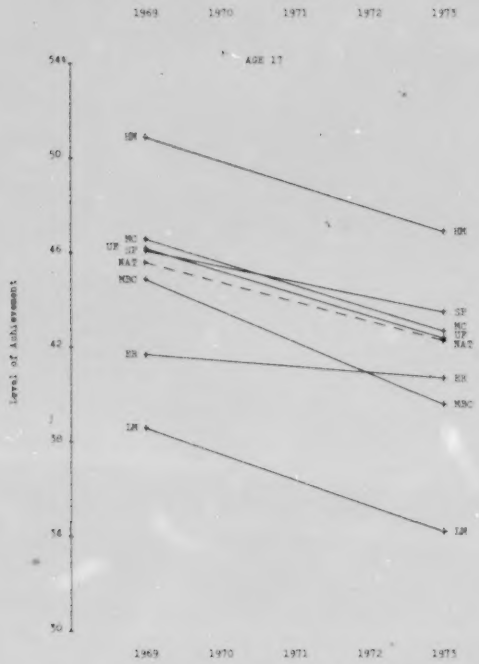
The age 9 extreme-rural category showed improved performance in 1973.



At age 13, the extreme-rural category again showed improved performance in the second assessment of science.

NAT = Nation
ER = Extreme rural
LM = Low metro
HM = High metro
MBC = Main big city
UF = Urban fringe
MC = Medium city
SP = Small places

EXHIBIT 23 (cont.). Average Changes in Performance for Size-and-Type-of-Community Categories at Ages 9, 13 and 17



Although extreme-rural performance declined slightly at age 17, this decline was far lower than that of the nation, resulting in improved position for the extreme rural.

NAT = Nation
ER = Extreme rural
LM = Low metro
HM = High metro
MBC = Main big city
UF = Urban fringe
MC = Medium city
SP = Small places

TABLE 15. Mean Differences Between Size-and-Type-of-Community Categories and the Nation, Ages 9, 13 and 17

	Mean Group Difference*					
					Change	
Age 9	1970	Standard Error	1973	Standard Error	Mean	Standard Error
Extreme rural	-5.9	(1.4)	-3.0	(1.0)	2.9	(1.7)
Low metro	-14.9	(1.2)	-13.4	(0.8)	1.5	(1.4)
High metro	8.1	(0.9)	7.1	(0.8)	-1.0	(1.2)
Main big city	-2.2	(1.0)	-1.5	(1.1)	0.7	(1.5)
Urban fringe	-2.2	(0.8)	1.6	(1.0)	-0.4	(1.2)
Medium city	1.1	(0.7)	1.5	(1.2)	0.3	(1.4)
Small places	1.2	(0.5)	0.7	(0.6)	-0.4	(0.8)
Age 13	1969	Standard Error	1972	Standard Error	Mean	Standard Error
Extreme rural	-6.2	(1.6)	-2.2	(1.2)	4.0	(2.0)
Low metro	-13.0	(1.1)	-13.5	(1.3)	-0.5	(1.7)
High metro	6.4	(0.9)	7.1	(0.8)	0.7	(1.2)
Main big city	-2.3	(1.3)	-2.5	(1.0)	-0.2	(1.6)
Urban fringe	3.0	(1.0)	0.8	(0.9)	-2.2	(1.4)
Medium city	1.4	(1.0)	1.2	(1.3)	-0.2	(1.6)
Small places	1.3	(0.5)	1.3	(0.6)	-0.0	(0.7)
Age 17	1969	Standard Error	1973	Standard Error	Mean	Standard Error
Extreme rural	-3.9	(1.1)	-1.6	(0.9)	2.3	(1.4)
Low metro	-6.9	(1.2)	-8.2	(1.3)	-1.2	(1.8)
High metro	5.4	(0.7)	4.5	(1.0)	-0.8	(1.2)
Main big city	-0.6	(0.8)	-2.8	(1.0)	-2.1	(1.2)
Urban fringe	0.7	(0.9)	0.0	(0.9)	-0.6	(1.3)
Medium city	1.0	(1.0)	0.4	(1.0)	-0.7	(1.4)
Small places	0.6	(0.5)	1.2	(0.5)	0.6	(0.7)

**Differences were obtained by subtracting the national percentage correct from the STOC-category percentage correct. A positive-mean group difference indicates average performance above the national average. A negative-mean group difference indicates average performance below the national average.*

years: an average of 13.0 percentage points below the nation in 1969 and 13.5 percentage points below in 1972. Only a few of the STOC categories showed much change in their relative standings: the urban-fringe advantage dropped from 3.0 percentage points above the nation in 1969 to only 0.8 percentage points in 1972. The extreme-rural 13-year-olds raised their relative position by 4 percentage points from 1969 to 1972 and thus narrowed the gap between their performance and that of all 13-year-olds.

Age 17

At age 17, as at ages 9 and 13, the high-metro category outperformed all other STOC categories in both assessments, by an average of 5.4 percentage points in 1969 and by 4.5 in 1973. Again, the low-metro category performed at the lowest level, although the magnitude of the difference between low metro and the nation was the smallest at age 17: an average of 6.9 percentage points below the nation in 1969 and 8.2 below in 1973. Most of the STOC categories did not change their relative positions by very much. The exception was again the extreme-rural category. Its relative position improved by 2.3 percentage points, from an average of 3.9 below in 1969 to 1.6 below in 1973.

Summary for Ages 9, 13 and 17

The extreme-rural respondents were the exception to the general declines in performance seen for the other STOC categories. At ages 9 and 13, their performance levels actually improved from the first to the second assessment. At age 17, although the extreme-rural respondents showed an average decline, this decline took place at a slower rate than for the nation. As a result, the extreme-rural respondents narrowed the gap between their performance and that of the nation. The high-metro students at all three ages continued to perform above the national level, although their performance declined at about the same rate as the nation. The low-metro students, typically the lowest achieving of the STOC categories did not improve their relative position.

CHAPTER 7

INTERPRETING THE RESULTS

When assessing change, National Assessment attempts to control as many things as possible, such as maintaining similar sample designs, administration procedures, packaging of exercises and time allowed for responses. Other changes naturally occur with the passage of time over which no one has control and that affect the changes NAEP observes. Following, we list some of these changes that might affect the interpretation of the science-change data.

Usage of "I Don't Know" Responses

Changes in the percentage of correct responses, which is the major focus of this report, should be interpreted in light of the changes in the percentage responding "I don't know." For each cognitive multiple-choice exercise, National Assessment includes "I don't know" among the possible choices (see the exercises in the Introduction in the section "Measuring Change"). At the beginning of each administration, respondents are instructed to mark the "I don't know" response if they do not know the answer. In addition, after reading each exercise, the announcer would also add, "If you do not know the answer, please fill in the oval beside 'I don't know'." National Assessment studies have shown that guessing seems to be reduced when the "I don't know" response is included, providing a more accurate estimate of the percentage who actually know the response.[1,2]

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[1]See N. Burton, R. C. Larson and A. M. Pearson, "The Effect of Position and Format on the Difficulty of Assessment Exercises," paper presented at the annual convention of American Educational Research Association, San Francisco, April 1976.

[2]Part of the successful usage of "I don't know" responses is due to National Assessment's rather unique testing situation in which individuals' scores are not reported. Thus, it is not necessarily an advantage to the student to guess the correct answer. This nonthreatening atmosphere is unlike many other testing situations where, of course, a premium is placed on getting as many correct responses as possible.

In the first assessment of science, 1969-70, it was found that different ages and different categories of respondents selected the "I don't know" response at different rates.[3] For example, girls and blacks tended to select "I don't know" more often than boys and whites. Generally, increased usage of "I don't know" was associated with fewer correct responses, although this was not always the case.

Since there were fewer correct responses in the 1972-73 assessment than in the 1969-70 assessment, we might expect more "I don't know" responses in the second assessment. In addition, we might expect to see an increase in the selection of other incorrect responses, indicating more misinformation, as in this exercise given to 13-year-olds in both assessments:

An average serving of which of the following foods would provide the most protein for building and repairing body tissues?

Age 13		
1969	1972	
4.8%	4.6%	Boiled potatoes
15.1	20.5	Green beans
53.2	49.3	Lean meat
7.2	7.9	Oatmeal
11.0	7.8	White bread
8.2	9.4	I don't know.
0.5	0.5	No response

Correct responses declined 3.9 percentage points, the "I don't know" responses increased 1.2 percentage points and the percentage of respondents who omitted the exercise ("no response" category) remained the same. Selection of the other incorrect responses (potatoes, beans, oatmeal and bread) increased by 2.7 percentage points (5.4 percentage points gain on green beans alone), indicating an increase in incorrect choices or an increase in misinformation. On this exercise, then, the decline in correct

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[3] 1969-1970 Science: National Results, Report 1, 1969-70 Assessment (Washington, D.C.: Government Printing Office, 1970); S. W. Sherman, "Group Differences in Responding 'I don't Know' as an Alternative in Multiple-Choice Exercises" (unpublished doctoral dissertation, University of North Carolina, Chapel Hill, N.C., 1974).

responses was accompanied by an increase in "I don't know" responses as well as other incorrect responses.

Exhibit 24 displays distributions of percentages responding "I don't know" on each exercise, for ages 9, 13 and 17, and for each science assessment. The means of these distributions are presented in Table 16, which adds mean percentages for selected categories of respondents; mean changes are also included in Table 16. Both exhibits indicate that 17-year-olds selected "I don't know" more often, on the average, than 9- and 13-year-olds. This is probably related to the increased difficulty of the 17-year-old exercises (means correct near 40-45%) compared to those given to 9- and 13-year-olds (means correct near 60%).[4]

In Appendix D there are additional tables giving the mean percentage of incorrect responses for ages 9, 13 and 17 as well as the mean percentage selecting "I don't know" and the mean percentage correct.

At age 9, there was a decline of 1.7 percentage points in the mean percentage of correct responses, a 1.9 percentage-point increase in incorrect responses and virtually no change for the "I don't know" response. This indicates an increase in misinformation or the tendency to guess. At age 13, there was a mean decline in correct responses of 1.9 percentage points, a rise of 1.1 for "I don't know" and 0.7 for incorrect. In the second assessment, there appears to be a slightly greater tendency for 13-year-olds to say "I don't know" and a very slight increase in incorrect responses. At age 17, there was a 3.2 percentage-point decrease in correct responses, a 1.1 percentage-point increase in "I don't know" and a 2.2 percentage-point increase in incorrect. The mean increase in the frequency of incorrect responses is twice that for "I don't know" and accounts for about two-thirds of the change in the mean percentage of correct responses.

For selected categories of respondents, we find that at age 9 there was little or no change in the frequency of the use of "I don't know" responses from one assessment to the next. However, there were some differences for categories of respondents aged 13 and 17.

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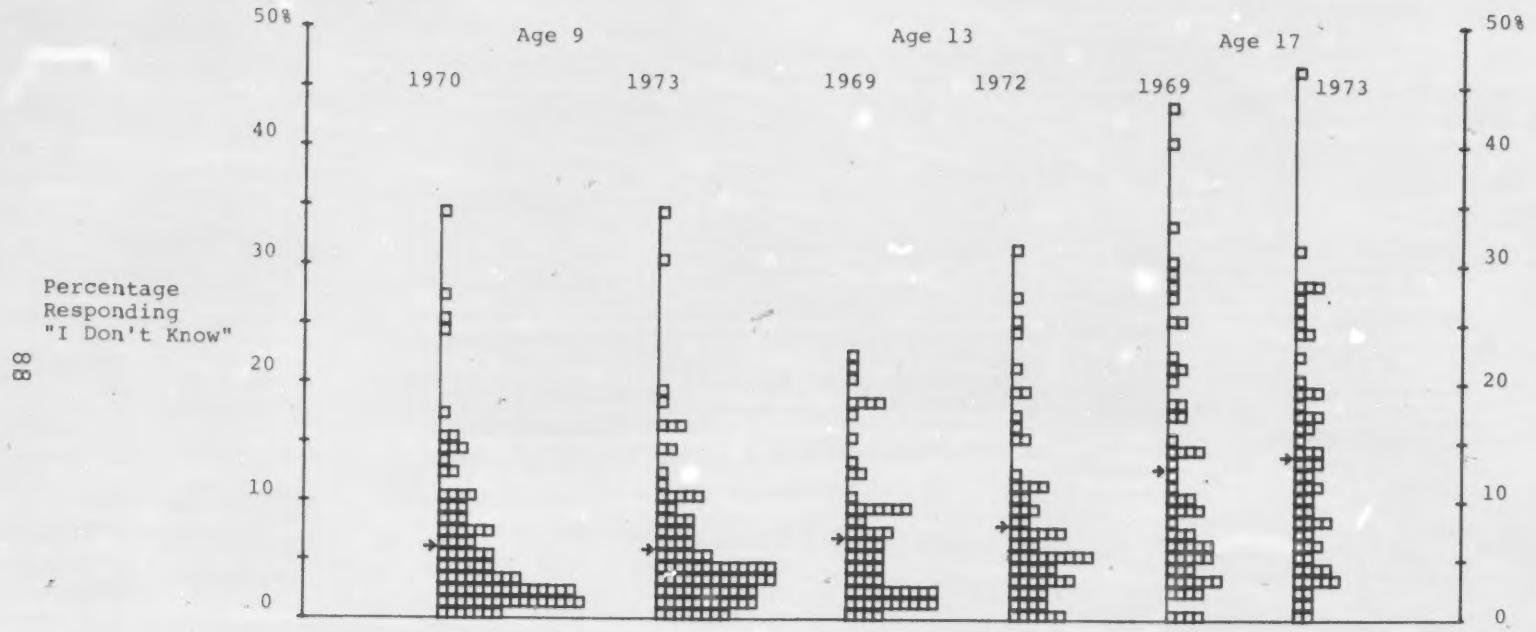
[4]When the same exercises were given to more than one age, the older ages actually responded "I don't know" less often than the younger ones, since almost without exception, on these exercises the older ages gave more correct responses than the younger ones.

EXHIBIT 24. Percentages Responding "I Don't Know" on Science Exercises: 1969-70 and 1972-73, Ages 9, 13 and 17



Each box -- 1% high -- represents the percentage selecting "I don't know" on one science exercise.
Arrows on each distribution indicate the mean percentage (see Table 16 for means).

TABLE 16. Mean Percentage Responding "I Don't Know" for Selected Categories of Respondents, Ages 9, 13 and 17

	Age 9			Age 13			Age 17		
	Mean % IDK* 1970	Mean % IDK* 1973	Mean Change**	Mean % IDK* 1969	Mean % IDK* 1972	Mean Change**	Mean % IDK* 1969	Mean % IDK* 1973	Mean Change**
Nation	6.2	6.0	-0.2	6.9	8.1	1.1	12.9	14.0	1.1
Northeast	6.0	5.4	-0.5	6.5	7.8	1.2	12.1	13.5	1.4
Southeast	6.2	6.8	0.6	6.1	7.3	1.2	12.0	13.3	1.3
Central	6.1	5.6	-0.5	6.9	8.5	1.7	13.7	14.3	0.6
West	6.5	6.1	-0.4	8.1	8.5	0.4	13.2	14.6	1.4
Boys	5.2	5.1	-0.1	6.1	7.1	1.0	11.3	12.2	0.9
Girls	7.2	6.8	-0.4	7.7	9.0	1.3	14.4	15.6	1.2
Whites	5.9	5.6	-0.2	6.6	7.6	1.0	12.9	13.6	0.7
Blacks	7.4	7.1	-0.3	7.9	9.9	2.0	12.3	15.3	2.9
Extreme rural	6.7	6.5	-0.3	8.3	7.5	-0.8	12.6	14.4	1.8
Low metro	7.7	7.6	-0.1	8.8	10.4	1.6	12.8	15.5	2.7
High metro	4.4	4.7	0.3	6.6	8.0	1.4	12.6	13.2	0.6

*Note: IDK stands for "I don't know."

**The mean change is the mean of the changes and may differ from the change in means because of rounding.

Sex differences in use of the "I don't know" alternative, which were fairly large in the first science assessment, were even larger for both 13- and 17-year-olds in the second assessment. In 1969-70, black 17-year-olds said "I don't know" far less often than would be expected on the basis of their large deficit in correct responses. In the second assessment, their performance declined less than whites, and they said "I don't know" more than before. Thus, in the second assessment 17-year-old blacks were either guessing less or had less misinformation than earlier. The performance of 13- and 17-year-olds in the Southeast, which was below that of the nation, improved somewhat relative to that of the nation as a whole. However, their use of the "I don't know" response increased over its 1969-70 level, which was higher than that for the nation.

Thus, it appears that group patterns of information and misinformation and response styles did change slightly since the first assessment of science in 1969-70. Some group differences in use of the "I don't know" response have decreased while some have increased. Some groups still use the "I don't know" response in ways not predictable by their frequency of correct responses.

Migration Between Regions

Between 1969-70 and 1972-73 many thousands of families moved from one region of the country to another. The people who were living in the Northeast in 1972-73 were not all the same people living in the Northeast in 1969-70. The characteristics of the Northeast, such as average education of adults or racial composition, may have changed in those three-to-four years. For example, in the 1972-73 assessment we learned that about 5-6% of the 13-year-olds indicated that they had lived in a different region at age 9. The effects of such movements are probably slight but should be remembered when interpreting the changes in performance presented in this report. To see how the characteristics of the regional categories have changed by sex, race, parental education and size and type of community, see Appendix C on the estimated population distributions for each assessment.[5]

Size and Type of Community

The seven size-and-type-of-community (STOC) reporting categories are comprised of three "extreme" types of community and

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[5]The impact of changing proportions on the change data is also explored in Appendix C.

four "residual" sizes of community. (See Chapter 6 for the definitions of these groups.) Each extreme category includes approximately 10%[6] of the respondents at each age level; the remaining respondents are classified according to one of the other four classifications. The definitions of the three extreme categories have remained the same during the two assessments; thus about 10%[6] of the respondents fall into each of the extreme categories (low metro, high metro and extreme rural). The obtained weighted distributions were:

Distributions of Respondents by Size and Type of Community*

	Age 9		Age 13		Age 17	
	1970	1973	1969	1972	1969	1973
Extreme rural	8.0%	8.9%	8.0%	10.3%	9.4%	8.6%
Low metro	6.5	8.1	7.9	7.2	7.4	8.5
High metro	11.7	12.7	11.3	11.5	9.5	12.1
Main big city	12.4	11.0	11.6	11.0	13.5	8.1
Urban fringe	13.0	13.2	11.7	14.4	10.6	15.3
Medium city	13.1	13.2	15.9	13.8	16.8	13.0
Small places	35.2	33.0	33.7	31.9	32.9	34.3

**The impact of changing proportions on the change data is explored in Appendix C.*

Every attempt was made to keep the definitions of these categories constant from the first to the second assessments. Even the definition of "size of cities" was kept constant by using 1970 Census data for both assessments. However, the characteristics of respondents identified by the STOC categories might have changed. For example, the "extreme" category definitions are based on the most extreme 10% of each year's sample of schools, which differs from year to year. In addition, the move to consolidate rural schools into those of neighboring towns may have put many children who were classified as extreme rural in the first assessment into small places in the second. These changes naturally occur with the passage of time. Some of the character-

[6]The definitions of extreme categories are based on 10% of the total number of respondents who participated in the assessment. The distributions presented here are based on the weighted distribution of respondents, which differs slightly from the sample distribution.

istics of the STOC categories and how these characteristics changed between 1969 and 1973 are presented in Appendix C.

Parents' Education Level

Because of the change in the wording of the questions used to determine the highest level of parents' education,[7] we are not emphasizing the results for these categories. Even if the questions had remained the same, the meaning of various levels of education may have changed. Education levels of adults seem to be increasing: more are graduating from high school and more tend to enroll in schooling beyond high school (college as well as adult education courses and vocational-technical training). Appendix C reports how the characteristics of the parents' education categories changed from 1969 to 1973 by region, sex, race, and size and type of community.[8]

Timeliness of the Exercises

The passage of time can also affect the exercises. They can become out-dated between assessments or become more familiar to students because of wide exposure, as in a TV commercial or through a current news event. New knowledge or technology may invalidate a correct response of a few years earlier.

Most of the questions asked in the two science assessments covered fundamental facts and principles of science plus the application of these facts and principles. Most of these are not likely to be affected by new scientific knowledge, as these examples illustrate:

> When a person faints, you should lay him down and keep him warm (ages 9 and 13 - Exercise 201104).
>
> If all green plants died, the most important effect on man would be that he would sooner or later die of starvation (age 13 - Exercise 201071).
>
> An average serving of lean meat provides more protein for building and repairing body tissues than boiled potatoes, green beans, oatmeal or white bread (age 13 - Exercise 101103).

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[7]See Appendix A for the exact wording of the questions.
[8]The impact of changing proportions on the change data is also explored in Appendix C.

Mineral fertilizer around a plant may cause it to die because the amount of water at the roots has been decreased (age 17 - Exercise 202087).

The length of time required for a pendulum bob to make one complete swing depends on the length of the pendulum string (age 17 - Exercise 102023).

Using a multiple-choice format that asks the respondent to select the best answer from those presented also helps alleviate the problem of new knowledge affecting responses.

As a possible example of how current events or trends may affect the correct responses, consider this item (Exercise 2040124) given to 9-year-olds in both assessments.

John has a flat tire on his bicycle. He pumps the tire up with an air pump and begins to ride. In a few minutes the tire is flat again. To fix his tire, John must find

- ○ a better air pump.
- ○ whether the tire is made of rubber.
- ● where the air leaks out of the tire.
- ○ how many minutes it takes the tire to go flat.
- ○ I don't know.

In 1970, 76% of the 9-year-olds responded correctly; in 1973, this number jumped by 12 percentage points to 88% correct. This increase may have occurred because of an increase in bike riding between 1970 and 1973 or because more 9-year-olds owned bikes in 1973 than in 1970.

Since there was only a three-to-four year span between the two science assessments, it is not likely that many were seriously outdated by 1972-73. However, as we look at changes over longer time periods, the timeliness of the exercises will become more crucial.

Changes in Science Curriculum

The decline in the number of young Americans demonstrating knowledge in science may simply reflect a change of emphasis in science curriculum or in the atmosphere of the schools. At age 17 there may have been fewer students electing to take science courses in 1972-73 than in 1969-70. It is possible that achievement levels may have improved among those students enrolled in

science curricula; National Assessment assesses all students, not just those interested in science. Teachers may well be doing a better job than ever with a select group of students who will form the nucleus of the next generation's scientific community.

The emphasis on the importance of science may have declined. The declines in performance may only suggest that unusual emphasis was given to science education in the wake of "Sputnik," and the new results reflect a return to more normal achievement levels.

Science educators are concerned about such questions and are the best sources of information on what changes have taken place in science curricula and the atmosphere of the schools. Perhaps they can provide some hard data on changes that took place and how these might have affected the changes in performance that we observed.

A Final Note

The average change in science achievement at ages 9, 13 and 17 was a decline of about 2-3 percentage points. Although there may be many reasons for these declines, we are living in a highly complex, technological world and this may be a poor time for such a decline. Average citizens must have some basic knowledge about science to remain informed about critical social and environmental issues upon which they are expected to make rational decisions. These science results raise many issues: How much science should citizens know, given the complexity of the world that confronts us? Are we training enough good scientists to meet the growing needs or our technological society? The public at large should join the scientific and education communities in discussing these issues.

Education is the largest single enterprise in the United States today. Three out of every 10 Americans are directly involved in the educational process, and expenditures have more than doubled in the last decade, with an estimated $54 billion being spent for elementary and secondary education in 1971 alone.[9] A great deal of effort has gone into improving the educational system. Yet, at least in science, there was a general decline in the knowledge levels of American youth between 1969-70 and 1972-73. Furthermore, the gap between national and group performance

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[9]W. V. Grant, "Education's New Scorecard," Selected Statistical Notes on American Education, Department of Health, Education and Welfare publication No. (OE) 73-111703 (Washington, D.C.: Government Printing Office, February 1973), pp. 3-8.

in science has not been narrowed for females, black Americans or students from low-metro schools. The facts highlighted in this report should stimulate discussions about national interest in science, school responsibility for science education and the long-term implications of a downward trend in science achievement.

APPENDIX A

CAUTIONS TO BE OBSERVED IN INTERPRETING CHANGE DATA: A DISCUSSION OF THE NONSAMPLING ERRORS OF CHANGE

As indicated in the main body of this report, National Assessment is essentially a survey of the knowledge, skills and attitudes of our nation's young people. As with any survey, NAEP results are subject to two sources of error: sampling and nonsampling. Sampling errors occur because responses are obtained only from a sample, not the entire population. Nonsampling errors occur in each assessment and may come from many sources: packaging of exercises, variability among exercise administrators, motivation of respondents, recording of responses and data-processing procedures. When assessing change, we try to hold constant as many conditions as possible so that the nonsampling errors will cancel out when a difference is obtained. National Assessment has tried to maintain constant conditions wherever possible (e.g., using the same exercises) in order to get the best possible measures of change.

However, some things did change between the first and second assessments of science: field procedures changed as we learned from each assessment, sample design changed slightly, school cooperation rates improved, packaging of the exercises was changed and there were shifts in the characteristics of categories of respondents from 1969 to 1973. The following pages will examine these nonsampling errors and discuss their possible effects on the measurement and interpretation of the science-change results.

Changes in Field Procedures

The first assessment of science occurred the first year that National Assessment began collecting data. As with any project, we naturally learn how to improve methods and what mistakes to avoid as we have more experience. The second assessment of science took place in the fourth year of data collection, by which time several improvements in the field conditions had occurred.[1]

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[1]In addition, the field staff was used to locate out-of-school respondents, aged 17 and young adults aged 26-35. In 1972-73, each out-of-school respondent was paid $5.00 for each package he took, up to four. In 1969-70 participants were not paid. Because of this motivational difference, change data for out-of-school 17-year-olds and adults are not reported here.

For example, the field staff used in 1972-73 had more experience and better training than in previous years. Better quality-control procedures were also implemented in 1972-73 in order to instruct field staff as soon as possible if there were problems in administration. Instructions on the use of probes with open-ended exercises were more complete in 1972-73 than in 1969-70.

Sampling Design

The sampling designs of the two assessments both employed a deeply-stratified, multistage probability sample. The major difference was the addition of an "all-states" requirement in 1972-73 that specified that all 50 states be represented in the national sample. National Assessment's sampling experts have indicated that this requirement increased the precision of the measurements slightly, but the data and actual samples drawn were affected very little. The largest source of difference between the two years' samples is due to random-sampling variability, which always occurs between two samples; no systematic bias or difference between samples occurred as a result of slightly different designs.

Identification of Race

In 1969-70, exercise administrators visually identified respondents as white, black or other. In 1972-73, partially in response to groups wanting information on other minority groups, the exercise administrators were asked to classify respondents into one of five categories -- white, black, Puerto Rican, Mexican-American or other -- using visual identification and surname. When there was a question, the administrator was advised to determine the language or dialect the student spoke. In all cases, Puerto Rican and Mexican-American identification took priority over other categories.

The degree to which this categorization into Puerto Rican and Mexican-American taking precedence over the racial identification affected the racial categories is not directly known. However, we can look at the percentage of respondents for all races in both assessments (see table on next page). These data seem to indicate that there was no systematic increase or decrease in the proportion categorized as black.

Parental Education

The wording of the questions asking for level of parents' education was changed slightly after the first assessment of science. In 1969-70 respondents were asked, "How far did your father,

Distribution of Respondents by Race*

	Age 9		Age 13		Age 17	
	1970	1973	1969	1972	1969	1973
Blacks	12.0%	14.4%	13.3%	12.6%	9.6%	12.0%
Whites	81.7	78.9	80.5	80.7	85.3	82.5
Others	6.3	6.7	6.1	6.6	5.1	5.5

**The impact of changing proportions on the change data is explored in Appendix C.*

or the man living in your home who acts as your father, go in school?" A similar question was asked about the respondent's mother. In 1972-73 the wording was simplified to: "How much school did your father complete?" Again, a similar question was asked about the mother's schooling. It should be noted that only the form of the question differed: the categories used by the respondent to indicate highest level of parents' schooling were the same.

The estimated proportions for the categories of reported parental education were:

Distributions of Respondents by Highest Reported Level of Parental Education*

	Age 9		Age 13		Age 17	
	1970	1973	1969	1972	1969	1973
No high school	4.5%	5.0%	4.2%	6.7%	5.1%	6.8%
Some high school	5.4	4.4	9.7	8.2	14.3	10.3
Graduated high school	23.3	20.9	31.4	30.1	33.0	30.8
Post high school	33.9	30.6	45.3	40.4	46.0	45.9
Unknown	32.9	39.1	9.4	14.7	1.6	6.2

**The impact of changing proportions on the change data is explored in Appendix C.*

The "unknown" category showed increases at all three ages; these were the respondents who answered "I don't know" for both parents' education levels. It is not clear if this was a result of the changes in wording or an increased willingness of students to admit that they did not know how far their parents went in school.

Because of these discrepancies, summary-change data for the parental-education categories are presented only in the Appendix; no text was reported about the results.

Administration of the Exercises

In each assessment conducted by National Assessment, the exercises to be given to a particular age level are grouped into booklets -- called "packages" -- and printed. Tape recordings of the exercises are then produced to accompany the packages. Each package usually contains about 35 minutes of exercise time and 15 minutes for administration of the packages. Since each in-school respondent takes only one package, he spends a maximum of 50 minutes participating in the assessment.

In 1969-70, in addition to science, National Assessment also assessed citizenship and writing. In 1972-73, mathematics and science were assessed. To provide variety for the respondents, exercises from each area were included in each package. For example, in 1972-73 each respondent taking a package responded to some mathematics exercises and some science exercises.

Because of the changes in the learning areas assessed from 1969-70 to 1972-73, the physical arrangement of the science exercises changed. The following paragraphs describe some of these changes and their possible effects on the achievement data.

Learning-Area Mix

In 1969-70, science exercises were administered in packages containing writing and citizenship exercises; in 1972-73, science was administered with mathematics. The citizenship and writing exercises were short-answer or essay exercises. Many did not deal with factual material. Most of the mathematics exercises required a respondent to compute and record his own answer. Most of the mathematics exercises were short; the citizenship and writing exercises were longer. Although the total time was the same in each assessment (about 40 minutes per respondent), having to respond to many short exercises rather than a few long ones may have had an effect on the fatigue and boredom of the respondents.

Position in Package

Since different packages of exercises were used in the two assessments, the position of the exercises within a package changed. Exercises first in package or last in package seemed to be the most critical. It has been suggested that examinees may not do very well on the first exercise in a testing situation due to the initial tension examinees sometimes feel.[2] As a result,

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[2]R. L. Ebel, Measuring Educational Achievement (Englewood Cliffs, N. J.: Prentice Hall, 1965).

some test-makers prefer to begin the test with several rather easy items. In addition, performance on the last item in a testing situation may be lower than expected if some examinees do not have time to complete the item. The following section looks at first-in-package and last-in-package exercises in the two assessments to determine what effect, if any, changing the position of an exercise had on performance levels.

Twenty-one science exercises (seven at each age) appeared as the first exercises in a package in the first assessment (see Table A-1). Most of these exercises were fairly easy, with performance levels mostly in the seventies, eighties and nineties. At age 9 the seven first-in-package exercises, which appeared in other locations in the second assessment, had a mean change of 0.9 percentage points, indicating that the performance levels of the second assessment were very close to those observed in the first. At ages 13 and 17 the first-in-package exercises were generally harder when placed elsewhere in the second assessment. For both ages the first-in-package exercises showed average declines in performance -- a mean decline of 2.6 percentage points at age 13 and a mean decline of 4.9 percentage points at age 17. Both of these declines were slightly larger than those seen for all science exercises (mean declines of 1.9 for age 13 and 3.2 for age 17).

A total of eight science exercises appeared as the first exercises in a package in the second assessment (see Table A-2). Over all three ages, there was a slight trend toward worse performance in the second assessment, where the exercises were first in a package. This was especially noticeable for two exercises (204095 and 205023) that showed drops of close to 9 percentage points.

In summary, of the 29 exercises that were first in a package in one of the assessments, 11 were harder when placed first in a package. Eighteen were easier when placed first in a package. Although these results are confounded with changes in the knowledge of respondents, they tend to indicate that performance on a National Assessment exercise is not unduly hindered when it is placed first in a package.

Similarly, National Assessment exercises placed last in a package should not be unduly affected. Exercises are read aloud to the respondents using a paced tape that allows ample response time for each exercise before moving on to the next exercise. Respondents should be turning their pages according to the instructions on the tape, keeping respondents together. Since all exercises are treated in this manner, exercises last in package should not be affected by lack of time. A general fatigue effect may be present toward the end of the testing situation, although each respondent is tested for only about 40-45 minutes. In addition,

TABLE A-1. Exercises Placed First in Package in 1969-70 Assessment

Age 9

NAEP #	1970 Pkg-Ex	1973 Pkg-Ex	1970 % Correct	Change*	Standard Error	Description
204124	02-01	01-06	75.7	12.0	(1.8)	To fix his bicycle tire, John must find where the air leaks out of it.
101078	04-01	03-19	87.7	5.0	(1.3)	The rabbit, and not the cat, dog or lion, eats only plants.
101086	06-01	05-11	95.5	2.3	(0.8)	Text for this exercise was not released.
101071	03-01	06-06	95.1	0.2	(0.8)	The Sun is hotter than Earth, Mars or the moon.
101083	05-01	02-20	87.2	-0.3	(1.6)	A bat usually hunts for food ONLY at night, but a dog, horse and hummingbird do not.
101096	08-01	06-33	92.9	-3.7	(1.2)	Fish can be weighed on a scale, but freedom, friendship and fun cannot.
101091	07-01	02-15	75.3	-9.0	(2.0)	Iron is more likely to rust when it is damp than when it is dry, painted or covered with grease or soap.

*1973 percentage minus 1970 percentage.

Age 13

NAEP #	1969 Pkg-Ex	1972 Pkg-Ex	1969 % Correct	Change*	Standard Error	Description
205018	02-01	02-24	72.5	2.0	(1.8)	Scientists would have more trouble testing whether my dog is better than your dog than the other choices listed.
101092	09-01	03-12	94.9	0.7	(1.0)	Text for this exercise was not released.
101119	07-01	06-20	69.7	0.3	(2.0)	A powder of black and white specks is a mixture, not sugar, pepper, an element or a pure compound.
101082	05-01	06-08	80.9	-3.0	(2.0)	Text for this exercise was not released.
102030	03-01	07-06	37.0	-4.0	(2.2)	The density of the human body is most nearly equal to the density of water, not air, cork, hydrogen or iron.
101114	06-01	09-19	74.4	-5.9	(1.8)	Seeds come from the flower, not the bark, leaf, root or stem of the plant.
101120	08-01	03-06	58.5	-8.2	(2.2)	The time it takes the Moon to go from new moon to full moon and back to new moon is about 28 days.

*1973 percentage minus 1969 percentage.

Age 17

NAEP #	1969 Pkg-Ex	1973 Pkg-Ex	1969 % Correct	Change*	Standard Error	Description
101131	02-01	01-05	72.4	-1.4	(2.2)	A frog is a vertebrate, but a clam, octopus, spider and starfish are not.
101133	04-01	11-03	87.7	-2.0	(1.5)	A lizard is an animal, but bacterium, moss, snap dragon and toadstool are not.
101115	10-01	01-27	75.6	-2.2	(2.1)	Text for this exercise was not released.
201079	09-01	03-09	72.1	-4.5	(2.0)	In hot climates, the advantage of buildings with white surfaces is that they reflect, not absorb or refract light.
101116	07-01	11-24	61.6	-4.5	(2.1)	Of the listed choices, cancer is best described as uncontrolled cell division.
101132	03-01	04-15	88.4	-9.2	(1.4)	Text for this exercise was not released.
102023	05-01	06-29	61.5	-10.4	(2.0)	The length of time required for a pendulum bob to make one complete swing depends on the length of the pendulum string.

*1973 percentage minus 1969 percentage.

TABLE A-2. Exercises Placed First in Package in 1972-73 Assessment

Age 9

NAEP #	1973 Pkg-Ex	1970 Pkg-Ex	1970 % Correct	Change*	Standard Error	Description
303084	02-01	03-20	86.0	3.1	(1.5)	Text for this exercise was not released.
303086	03-01	05-17	83.4	2.1	(1.4)	Text for this exercise was not released.
303087	06-01	06-17	72.0	-1.7	(2.0)	It is not true that breaking a mirror brings bad luck.

*1973 percentage minus 1970 percentage.

Age 13

NAEP #	1972 Pkg-Ex	1969 Pkg-Ex	1969 % Correct	Change*	Standard Error	Description
101118	05-01	06-08	93.2	0.3	(1.1)	The only star you usually see in the daytime is the Sun, not Venus, the Moon, the Pole Star, or Alpha Centauri.
101108	08-01	04-03	85.7	-1.5	(1.4)	Of those listed, the most important job for the lungs is to provide a place for oxygen to enter the blood.
204095	04-01	03-03	79.3	-8.5	(2.1)	That Siamese cats are prettier than other cats is an opinion rather than a fact about cats.

*1972 percentage minus 1969 percentage.

Age 17

NAEP #	1973 Pkg-Ex	1969 Pkg-Ex	1969 % Correct	Change*	Standard Error	Description
101127	07-01	10-11	78.4	3.1	(1.6)	Text for this exercise was not released.
205023	05-01	05-15	34.6	-8.8	(2.2)	Text for this exercise was not released.

*1973 percentage minus 1969 percentage.

as the physical end of the testing situation approaches, respondents may be less careful in their responses in their eagerness to finish the task.

In the first assessment, no science exercises were assigned to last-in-package positions. Those locations were reserved for writing exercises. In the second assessment, nine science exercises, which had been in different positions in the first assessment, appeared last in a package. These exercises are listed by age in Table A-3.

All exercises showed worse performance in the second assessment when they were placed last in the package. As with the first-in-package exercises, it is difficult to know how much of the changes are due to real changes in knowledge and how much is due to changes in position.

In summary, it appears that lowered performance on first-in-package exercises is not generally the case; instead, there seems to be generally higher performances on these exercises than when placed in other package positions. However, there does seem to

TABLE A-3. Exercises Placed Last in Package in 1972-73 Assessment

Age 9

NAEP #	1973 Pkg-Ex	1970 Pkg-Ex	1970 % Correct	Change*	Standard Error	Description
204087	06-35	07-07	95.5	-5.3	(1.0)	The SUREST sign that a dog is sick is its not having eaten its food for two days.
201064	03-35	04-12	74.9	-8.3	(2.2)	Text for this exercise was not released.

*1973 percentage minus 1970 percentage.

Age 13

NAEP #	1972 Pkg-Ex	1969 Pkg-Ex	1969 % Correct	Change*	Standard Error	Description
101069	04-33	07-03	82.5	-7.0	(1.9)	Each year the Earth moves once around the Sun, not Mars, Venus, the moon or all the planets.
202083	03-33	07-05	68.0	-7.1	(1.8)	It takes the most energy to stop a heavy car going 40 miles per hour from the choices given.

*1972 percentage minus 1969 percentage.

Age 17

NAEP #	1973 Pkg-Ex	1969 Pkg-Ex	1969 % Correct	Change*	Standard Error	Description
204103	08-29	04-02	66.3	-4.9	(2.4)	That the rings of Saturn were formed when a moon exploded is a hypotheses rather than a fact.
101143	05-29	07-14	27.0	-5.6	(1.8)	Text for this exercise was not released.
102023	06-29	05-01	61.5	-10.4	(2.0)	The length of time required for a pendulum bob to make one swing depends on the length of the pendulum string.
101137	09-29	06-05	68.6	-12.4	(2.0)	One example of oxidation is the burning of wood in air, not neutralizing an acid or forming ice from water.
204109	04-29	09-20	49.0	-14.1	(2.2)	Describe a way to test whether or not it pays to buy premium gasoline for a secondhand car.

*1973 percentage minus 1969 percentage.

be some evidence that the performance on last-in-package exercises is lower than when these exercises are placed elsewhere. However, all results are confounded with real changes in knowledge so that it is difficult to determine the effect of changing positions. Further analysis on the changes in position is being planned for the next assessment of science, scheduled for 1976-77.

Taping

There were some slight variations in the taping of the exercises. A new tape was made in the second assessment since there were different exercises administered with science and since their position in the packages, and hence on the tape, also differed. A different announcer was used, but in both assessments the announcers read very clearly and at the same rate. There was a

slight change in the introductory remarks, transitional remarks between exercises and instructions on the use of "I don't know." All of the statements contained the same information in both assessments; only the phrasing changed.

Printing

Instructions on the bottom of each page telling respondents to stop or to continue on to the next page were given additional adornments in the second assessment: "Stop" appeared in an octagon and "Please Continue on the Next Page" appeared in an arrow. In addition, there were slight changes in the sizes of print and type faces used in the two assessments. Both sets of printing have been judged by National Assessment's reading consultants to be easily readable at the appropriate age levels.

Released and Reassessed Exercises

As part of a general research effort on the measurement of change, we included a few items that had been released after the first assessment. Our main concern was whether or not these items would be used in the classrooms, thus perhaps inflating the percentage of respondents correctly answering these items in the second assessment. The data collected on released/reassessed exercises are presented in Tables A-4 through A-6.

There were 10 such released/reassessed items at age 9. Only 3 showed more respondents answering correctly in 1973; 7 showed fewer correct answers. One exercise showed an increase of 12 percentage points: To fix his bicycle tire, John must find where the air leaks out of it. The improved performance on this exercise may be more related to the increased use of bicycles than to the fact that it was released after the first assessment.

At age 13, six exercises were released before the second assessment. Five of these showed gains in 1972; one showed a loss. Two showed rather large gains: (1) of three blocks with equal volume, the one that floats the lowest is the heaviest; and (2) in terms of natural selection, giraffes with longest necks got food when scarce and passed this trait onto its young. At least at age 13 the released exercises showed changes in performance different from the general decline observed with the majority of change exercises.

Four exercises were released/reassessed at age 17. Performance went up on one and declined on the other three, following the general downward trend seen for the rest of the change exercises given to 17-year-olds. The exercise on the theory of natural selection, which showed a rather large increase for 13-year-

TABLE A-4. Released/Reassessed Science Exercises, Age 9

NAEP #	1970 Rel #	1973 Rel #	Age 9 1970 % Correct	Change	Age 9 Standard Error	Description
101068	R134	RB103	46.0	-0.5	(2.2)	Houseflies and not ants, honeybees or moths spread serious human disease.
201067	R141	RP175	7.1	-0.7	(1.0)	A pint of water 50 degrees F. mixed with a pint of water 70 degrees F. yields water that is ABOUT 60 degrees F.
202106	R135	RP206	38.2	-4.5	(1.9)	Breaking a rock into three pieces does not change the level of water in the container holding the rock.
204088	R151	RB219	54.4	1.0	(2.1)	Choose the graph that correctly shows the amount of growth of a plant that is given for each of three weeks.
204090	R147	RU221	68.9	-0.2	(1.9)	Let stand a mixture of salt, sugar and water to test an idea about how salt water taffy is made.
204124	R146	RP234	75.7	12.0	(1.8)	To fix his bicycle tire, John must find where the air leaks out of it.
204128	R148	RB235	67.0	-0.7	(1.8)	Read a doctor's chart to determine that younger people breathe faster than older people.
204137	R133	RB236	46.2	-4.6	(1.8)	To say that seeds grow best in light, one should use same seeds, not different ones, watered equally, in dark and light.
205018	R157	RU238	39.4	1.1	(2.4)	Scientists would have more trouble testing whether my dog is better than your dog than testing the other choices listed.
205027	R159	RU240	23.0	-4.2	(1.7)	In science one is less likely to write poems about apples than to weigh, measure, describe their color or count their seeds.

olds, showed a significant decline for 17-year-olds.

Releasing an item might have a positive effect on the percentage of respondents correctly responding to an item. The evidence collected by National Assessment shows that releasing an item does not necessarily mean improved performance. Releasing an item has not, in general, countered the overall decline in science achievement, especially at ages 9 and 17. However, the data for age 13 indicates that released exercises may have larger increases than unreleased ones. Since it is not known how extensively the exercises were used by teachers, it is difficult to determine how many of these increases were the result of their release. In addition, these exercises may have shown improvements

TABLE A-5. Released/Reassessed Science Exercises, Age 13

			Age 13			
NAEP #	1969 Rel #	1972 Rel #	1969 % Correct	Change	Standard Error	Description
201072	R206	RP180	78.5	-3.9	(1.9)	Fanning makes a fire burn better because fanning increases the oxygen supply.
201104	R225	RB190	31.5	2.2	(1.8)	You should lay a person down and keep him warm when he faints.
202084	R228	RB195	25.9	0.2	(1.9)	An ocean fish fossil found in a rock outcrop on a mountain probably means the mountain was raised after the fish died.
202102	R232	RP205	75.1	7.8	(1.6)	Of three blocks with equal volume, the one that floats the lowest is the heaviest.
203022	R222	RB207	38.4	5.8	(1.9)	In terms of natural selection, giraffes with longest necks got food when scarce, and passed this trait onto its young.
205018	R242	RU238	72.5	2.0	(1.8)	Scientists would have more trouble testing whether my dog is better than your dog than the other choices listed.

TABLE A-6. Released/Reassessed Science Exercises, Age 17

			Age 17			
NAEP #	1969 Rel #	1973 Rel #	1969 % Correct	Change	Standard Error	Description
101147	R337	RP155	3.0	-0.5	(0.6)	Metal cans for holding foodstuffs are chiefly made of iron, not copper, nickel or tin.
101148	R330	RB156	29.0	-1.2	(2.1)	On the average, in human females, the egg is released 14, not 2, 9 or 20 days after menstruation begins.
203022	R314	RB207	60.2	-5.1	(2.1)	In terms of natural selection, giraffes with longest necks got food when scarce, and passed this trait onto its young.
204111	R347	RB232	19.6	0.4	(1.7)	That plants use starch in seeds and give off gases that escape explains why a flask with corn planted in it loses weight.

because they were timely or more interesting than others. Since the evidence on the effects of release seems to be inconclusive, National Assessment will continue to be cautious in releasing exercises; some will be kept secure for use in the next assessment.

Follow-Up of Nonsampling Errors

National Assessment is keenly aware of the possible effects of changes in procedures on our measurements of change and has taken care to standardize field procedures, to incorporate quality-control procedures in scoring and data analysis, and to maintain constant definitions of reporting categories. In future assessments it may be possible to assign exercises permanently to packages, one learning area per package, and to reassess or release these packages as complete units. This will alleviate the administration changes noted in the previous section, as well as reduce the costs of taping and printing. Analysts at National Assessment are also aware of possible scoring problems associated with changes over time, and rescoring of open-ended exercises is being done where necessary (and financially feasible). National Assessment will continue to control as many nonsampling errors as possible from one assessment to the next, since the measurement of change is one of its most important functions.

APPENDIX B

SUMMARY TABLES

TABLE B-1. Mean Changes in Performance for All Science Exercises: Ages 9, 13, 17, 1969-73

	Age 9 (92)						Age 13 (67)						Age 17 (64)					
	Mean % Correct 1970	Standard Error*	Mean % Correct 1973	Standard Error*	Mean Change**	Standard Error*	Mean % Correct 1969	Standard Error*	Mean % Correct 1972	Standard Error*	Mean Change**	Standard Error*	Mean % Correct 1969	Standard Error*	Mean % Correct 1973	Standard Error*	Mean Change**	Standard Error*
National	61.1	(0.4)	59.4	(0.5)	-1.7	(0.6)	60.2	(0.4)	58.3	(0.5)	-1.9	(0.6)	45.6	(0.3)	42.3	(0.3)	-3.2	(0.5)
Region																		
Northeast	63.4	(0.5)	61.3	(0.7)	-2.2	(0.9)	62.0	(0.8)	60.7	(0.9)	-1.3	(1.2)	47.9	(0.7)	44.4	(0.5)	-3.5	(0.8)
Southeast	55.8	(0.8)	55.4	(1.0)	-0.4	(1.3)	55.1	(1.1)	55.4	(0.9)	0.3	(1.4)	42.4	(0.6)	40.8	(0.6)	-1.6	(0.9)
Central	62.6	(0.7)	60.8	(0.9)	-1.8	(1.2)	62.6	(0.7)	59.9	(1.0)	-2.8	(1.2)	45.5	(0.5)	42.5	(0.8)	-3.0	(0.9)
West	61.4	(0.8)	60.0	(0.9)	-1.4	(1.2)	59.8	(0.6)	56.9	(0.9)	-2.9	(1.1)	45.6	(0.6)	41.1	(0.7)	-4.5	(0.9)
Sex																		
Males	62.2	(0.4)	60.5	(0.5)	-1.6	(0.6)	62.3	(0.5)	60.5	(0.5)	-1.9	(0.7)	48.8	(0.4)	45.3	(0.4)	-3.4	(0.6)
Females	60.0	(0.4)	58.4	(0.5)	-1.7	(0.6)	58.2	(0.5)	56.2	(0.5)	-2.0	(0.7)	42.6	(0.4)	39.6	(0.4)	-3.0	(0.5)
Race																		
Whites	64.1	(0.4)	62.6	(0.4)	-1.5	(0.5)	63.5	(0.3)	61.8	(0.4)	-1.7	(0.5)	47.2	(0.3)	44.5	(0.3)	-2.7	(0.5)
Blacks	47.0	(0.8)	46.1	(0.4)	-0.9	(0.9)	44.9	(0.6)	41.7	(0.5)	-3.2	(0.8)	33.9	(0.7)	32.0	(0.6)	-1.9	(0.9)
Other	50.3	(1.1)	51.5	(1.1)	1.1	(1.6)	49.6	(1.0)	47.5	(1.2)	-2.5	(1.6)	41.0	(1.2)	32.8	(1.0)	-8.2	(1.6)
Parental education																		
No high school	52.8	(1.0)	55.3	(0.9)	0.5	(1.3)	48.8	(0.9)	49.4	(1.0)	0.7	(1.3)	37.4	(0.7)	35.0	(0.7)	-2.4	(1.0)
Some high school	55.6	(0.9)	55.9	(0.9)	0.4	(1.2)	53.1	(0.8)	52.2	(0.7)	-0.9	(1.1)	40.4	(0.5)	36.3	(0.5)	-4.1	(0.7)
Graduated high school	61.5	(0.5)	60.5	(0.5)	-1.0	(0.7)	58.5	(0.5)	58.1	(0.5)	-0.4	(0.6)	43.9	(0.4)	41.1	(0.3)	-2.7	(0.5)
Post high school	67.0	(0.4)	65.1	(0.5)	-1.9	(0.6)	65.7	(0.4)	64.9	(0.4)	-0.9	(0.6)	49.5	(0.4)	46.7	(0.4)	-2.9	(0.5)
Unknown	56.8	(0.4)	55.6	(0.5)	-1.2	(0.6)	52.2	(1.0)	48.3	(0.6)	-3.8	(1.2)	38.7	(1.5)	34.0	(1.2)	-4.8	(1.9)
Size and type of Community																		
Extreme rural	55.3	(1.5)	56.5	(1.0)	1.2	(1.8)	54.0	(1.7)	56.2	(1.3)	2.2	(2.1)	41.7	(1.1)	40.7	(1.0)	-1.0	(1.4)
Low metro	46.2	(1.2)	46.0	(0.7)	-0.2	(1.4)	47.2	(1.1)	44.9	(1.3)	-2.3	(1.7)	38.6	(1.3)	34.2	(1.5)	-4.5	(1.8)
High metro	69.2	(1.0)	66.5	(0.8)	-2.7	(1.3)	66.6	(0.9)	65.4	(0.8)	-1.2	(1.2)	50.9	(0.7)	46.9	(1.1)	-4.1	(1.3)
Main big city	59.0	(1.0)	58.0	(1.2)	-1.0	(1.6)	57.9	(1.3)	55.8	(1.0)	-2.0	(1.6)	44.9	(0.8)	39.6	(1.0)	-5.4	(1.2)
Urban fringe	63.2	(0.8)	61.1	(0.9)	-2.1	(1.2)	63.2	(1.0)	59.1	(0.9)	-4.1	(1.3)	46.2	(0.9)	42.4	(1.0)	-3.9	(1.5)
Medium city	62.3	(0.7)	60.9	(1.3)	-1.3	(1.5)	61.6	(1.0)	59.5	(1.4)	-2.1	(1.8)	46.6	(1.1)	42.7	(1.1)	-3.9	(1.5)
Small places	62.3	(0.6)	60.2	(0.8)	-2.1	(1.0)	61.5	(0.6)	59.6	(0.7)	-1.9	(0.9)	46.1	(0.6)	43.5	(0.5)	-2.6	(0.8)

NOTE: Number of exercises is in parentheses.

All standard errors in this table are rounded figures. The standard error of change is calculated from the 1969-70 standard error (SE_1) and the 1972-73 standard error (SE_2) using the formula $(SE_1^2 + SE_2^2)^{\frac{1}{2}}$.

**The mean change is the mean of the changes in performance for the exercises. The mean change is equal to the difference in the means of each year, but may differ in this chart due to rounding.*

TABLE B-2. Mean Group Differences for All Science Exercises: Ages 9, 13, 17, 1969-73

	Age 9 (92)						Age 13 (67)						Age 17 (64)					
	Mean Group Diff. 1970	Standard Error*	Mean Group Diff. 1973	Standard Error*	Mean Change**	Standard Error*	Mean Group Diff. 1969	Standard Error*	Mean Group Diff. 1972	Standard Error*	Mean Change**	Standard Error*	Mean Group Diff. 1969	Standard Error*	Mean Group Diff. 1973	Standard Error*	Mean Change**	Standard Error*
National	61.1	(0.4)	59.4	(0.5)	-1.7	(0.6)	60.2	(0.4)	58.3	(0.5)	-1.9	(0.6)	45.6	(0.3)	42.3	(0.3)	-3.2	(0.5)
Region																		
Northeast	2.3	(0.5)	1.8	(0.6)	-0.5	(0.8)	1.8	(0.7)	2.4	(0.8)	0.5	(1.0)	2.3	(0.6)	2.0	(0.5)	-0.3	(0.8)
Southeast	-5.4	(0.7)	-4.1	(0.9)	1.3	(1.1)	-5.1	(0.9)	-2.9	(0.9)	2.2	(1.3)	-3.2	(0.6)	-1.6	(0.6)	1.7	(0.8)
Central	1.5	(0.6)	1.4	(0.8)	-0.1	(1.0)	2.4	(0.6)	1.6	(0.8)	-0.9	(1.0)	-0.1	(0.5)	0.2	(0.6)	0.3	(0.8)
West	0.2	(0.7)	0.6	(0.8)	0.3	(1.1)	-0.4	(0.6)	-1.4	(0.8)	-1.0	(1.0)	0.0	(0.5)	-1.2	(0.6)	-1.2	(0.8)
Sex																		
Males	1.0	(0.1)	1.1	(0.1)	0.0	(0.2)	2.1	(0.2)	2.1	(0.2)	-0.0	(0.3)	3.2	(0.2)	3.0	(0.2)	-0.2	(0.3)
Females	-1.1	(0.2)	-1.1	(0.1)	0.0	(0.2)	-2.0	(0.2)	-2.1	(0.2)	-0.1	(0.3)	-3.0	(0.2)	-2.8	(0.2)	0.3	(0.3)
Race																		
Whites	2.9	(0.2)	3.1	(0.3)	0.2	(0.3)	3.3	(0.3)	3.5	(0.3)	0.2	(0.4)	1.6	(0.2)	2.1	(0.2)	0.5	(0.3)
Blacks	-14.2	(0.7)	-13.4	(0.6)	0.8	(0.9)	-15.3	(0.6)	-16.6	(0.6)	-1.4	(0.8)	-11.6	(0.7)	-10.3	(0.6)	1.3	(0.9)
Other	-10.8	(1.0)	-8.1	(1.1)	2.7	(1.5)	-10.6	(1.0)	-11.0	(1.1)	-0.4	(1.5)	-4.6	(1.2)	-9.5	(1.0)	-5.0	(1.6)
Parental education																		
No high school	-8.5	(0.9)	-6.1	(0.8)	2.2	(1.1)	-11.4	(0.9)	-8.9	(0.9)	2.5	(1.2)	-8.2	(0.7)	-7.4	(0.7)	0.8	(1.0)
Some high school	-5.6	(0.8)	-3.5	(0.8)	2.1	(1.1)	-7.1	(0.7)	-6.1	(0.6)	1.0	(0.9)	-5.2	(0.4)	-6.0	(0.5)	-0.8	(0.7)
Graduated high school	0.4	(0.4)	1.1	(0.3)	0.7	(0.5)	-1.7	(0.3)	-0.2	(0.3)	1.5	(0.5)	-1.7	(0.3)	-1.2	(0.3)	0.5	(0.4)
Post high school	5.9	(0.3)	5.7	(0.2)	-0.2	(0.4)	5.5	(0.3)	6.6	(0.3)	1.0	(0.4)	4.0	(0.3)	4.3	(0.3)	0.4	(0.4)
Unknown	-4.5	(0.3)	-3.9	(0.2)	0.4	(0.4)	-8.0	(1.0)	-10.0	(0.5)	-1.9	(1.1)	-6.8	(1.5)	-8.4	(1.1)	-1.5	(1.8)
Size and type of Community																		
Extreme rural	-5.9	(1.4)	-3.0	(1.0)	2.9	(1.7)	-6.2	(1.6)	-2.2	(1.2)	4.0	(2.0)	-3.9	(1.1)	-1.6	(0.9)	2.3	(1.4)
Low metro	-14.9	(1.2)	-13.4	(0.8)	1.5	(1.4)	-13.0	(1.1)	-13.5	(1.3)	-0.5	(1.7)	-6.9	(1.2)	-8.2	(1.3)	-1.2	(1.8)
High metro	8.1	(3.9)	7.1	(0.8)	-1.0	(1.2)	6.4	(0.9)	7.1	(0.8)	0.7	(1.2)	5.4	(0.7)	4.5	(1.0)	-0.8	(1.2)
Main big city	-2.2	(1.0)	-1.5	(1.1)	0.7	(1.5)	-2.3	(1.3)	-2.5	(1.0)	-0.2	(1.6)	-0.6	(0.8)	-2.8	(1.0)	-2.1	(1.2)
Urban fringe	2.1	(0.8)	1.6	(1.0)	-0.4	(1.2)	3.0	(1.0)	0.8	(0.9)	-2.2	(1.4)	0.7	(0.9)	0.0	(0.9)	-0.6	(1.3)
Medium city	1.1	(0.7)	1.5	(1.2)	0.3	(1.4)	1.4	(1.0)	1.2	(1.3)	-0.2	(1.6)	1.0	(1.0)	0.4	(1.0)	-0.7	(1.4)
Small places	1.2	(0.5)	0.7	(0.6)	-0.4	(0.8)	1.3	(0.5)	1.3	(0.6)	-0.0	(0.7)	0.6	(0.5)	1.2	(0.5)	0.6	(0.7)

NOTE: Number of exercises is in parentheses.

**All standard errors in this table are rounded figures. The standard error of change is calculated from the 1969-70 standard error (SE_1) and the 1972-73 standard error (SE_2) using the formula $\sqrt{SE_1^2 + SE_2^2}$.*

***The mean change is the mean of the changes in performance for the exercises. The mean change is equal to the difference in the means of each year, but may differ in this chart due to rounding.*

TABLE B-3. Median Changes in Performance for All Science Exercises: Ages 9, 13, 17, 1969-73

	Age 9 (92)			Age 13 (67)			Age 17 (64)		
	Median % Correct 1970	Median % Correct 1973	Median Change*	Median % Correct 1969	Median % Correct 1972	Median Change*	Median % Correct 1969	Median % Correct 1973	Median Change*
National	66.7	63.1	-1.2	60.4	59.0	-2.1	46.4	39.8	-2.8
Region									
Northeast	70.6	67.9	-2.3	62.4	63.6	-1.8	48.2	43.6	-3.6
Southeast	60.3	57.9	-0.2	53.7	55.1	0.4	40.9	36.2	-1.3
Central	69.4	65.5	-1.8	62.6	61.3	-3.3	44.5	38.9	-2.3
West	67.0	62.9	-1.9	61.2	54.8	-2.9	47.4	39.8	-3.5
Sex									
Males	69.0	64.4	-1.1	62.3	60.1	-1.9	49.6	43.2	-2.2
Females	65.4	62.4	-1.4	58.3	58.0	-1.7	40.7	34.2	-2.4
Race									
Whites	70.7	68.8	-1.6	63.6	62.9	-1.4	48.9	44.3	-2.1
Blacks	46.0	44.3	-1.3	41.7	39.0	-3.1	28.8	26.1	-0.7
Other	52.7	51.1	1.9	48.2	48.4	-1.9	40.7	27.6	-6.6
Parental education									
No high school	54.5	52.7	0.7	47.0	48.4	2.1	33.6	28.0	-2.5
Some high school	58.1	56.4	0.1	49.4	53.1	-0.3	34.3	31.1	-3.3
Graduated high school	68.0	65.8	-0.8	57.0	57.9	-0.3	43.0	38.9	-2.1
Post high school	74.1	71.3	-1.7	68.3	67.2	-1.2	52.5	47.5	-2.3
Unknown	60.3	57.5	-1.4	50.6	46.1	-2.9	36.9	29.3	-4.3
Size and type of Community									
Extreme rural	56.8	59.8	1.3	50.4	53.9	2.8	37.3	37.0	-0.3
Low metro	46.7	45.7	-1.1	43.3	42.6	-1.5	33.6	30.0	-4.2
High metro	78.0	72.8	-2.8	68.4	69.1	-0.9	53.6	46.6	-1.9
Main big city	63.7	62.0	-1.0	58.8	56.2	-0.3	46.4	33.9	-2.7
Urban fringe	69.4	67.4	-2.2	64.2	58.5	-3.8	45.8	43.1	-3.3
Medium city	67.0	65.8	-1.2	62.0	61.4	-2.6	44.1	44.6	-4.5
Small places	68.5	64.3	-2.2	60.0	59.6	-1.2	47.5	41.3	-1.6

NOTE: Number of exercises is in parentheses.

**The median change is the median of the changes in performance for the exercises. The median change is not necessarily equal to the difference in the medians of each year.*

TABLE B-4. Median Group Differences for All Science Exercises: Ages 9, 13, 17, 1969-73

	Age 9 (92)			Age 13 (67)			Age 17 (64)		
	Median Group Diff. 1970	Median Group Diff. 1973	Median Change*	Median Group Diff. 1969	Median Group Diff. 1972	Median Change*	Median Group Diff. 1969	Median Group Diff. 1973	Median Change*
National	66.7	63.1	-1.2	60.4	59.0	-2.1	46.4	39.8	-2.8
Region									
Northeast	2.2	1.8	-0.4	1.9	2.2	0.7	2.2	1.8	-0.5
Southeast	-5.5	-4.8	1.6	-4.7	-2.9	1.8	-3.2	-1.5	1.5
Central	1.6	1.6	0.2	1.9	1.4	-0.8	-0.2	-0.5	0.3
West	0.2	0.6	0.0	-0.4	-1.1	-1.4	0.4	-0.4	-0.2
Sex									
Males	0.8	0.9	0.1	1.8	2.0	-0.1	2.7	2.5	-0.2
Females	-0.9	-0.9	0.0	-1.7	-1.9	-0.0	-2.6	-2.4	0.3
Race									
Whites	2.9	3.2	0.2	3.3	3.6	0.3	1.4	2.5	0.5
Blacks	-12.8	-12.5	0.1	-15.0	-16.4	-1.2	-11.8	-10.7	1.5
Other	-10.9	-8.0	3.3	-10.3	-11.7	-1.3	-2.9	-9.8	-2.7
Parental education									
No high school	-7.0	-6.1	2.2	-12.3	-8.7	1.5	-8.4	-7.5	0.6
Some high school	-5.3	-3.0	1.8	-6.5	-5.9	0.9	-4.4	-6.0	-1.0
Graduated high school	0.3	1.3	0.7	-1.5	-0.2	1.3	-1.6	-1.1	0.3
Post high school	6.0	5.8	0.1	5.2	6.3	0.8	3.9	3.8	0.5
Unknown	-4.5	-3.9	0.4	-8.0	-10.4	-1.7	-6.7	-8.0	-0.8
Size and type of Community									
Extreme rural	-5.5	-2.9	2.5	-6.3	-2.0	3.9	-3.6	-0.4	2.6
Low metro	-13.8	-13.6	1.1	-12.3	-13.2	0.0	-6.1	-7.0	-1.1
High metro	8.1	6.7	-1.6	6.5	7.3	0.3	5.1	4.8	-0.6
Main big city	-1.8	-1.6	0.4	-2.6	-1.7	0.3	-0.7	-2.2	-1.2
Urban fringe	2.1	1.9	-0.4	2.9	1.1	-1.7	0.7	-0.1	-0.6
Medium city	0.8	0.9	1.2	1.5	0.8	-0.1	0.3	0.7	-0.9
Small places	1.0	0.7	-0.4	1.3	1.3	0.5	0.6	1.0	0.7

NOTE: Number of exercises is in parentheses.

**The median change is the median of the changes in performance for the exercises. The median change is not necessarily equal to the differences in the medians of each year.*

TABLE B-5. Mean Changes in Performance by Type of Science: Age 9, 1970-73

	Physical Science (50)						Biological Science (27)						Unclassified (15)					
	Mean % Correct 1970	Standard Error*	Mean % Correct 1973	Standard Error*	Mean Change**	Standard Error*	Mean % Correct 1970	Standard Error*	Mean % Correct 1973	Standard Error*	Mean Change**	Standard Error*	Mean % Correct 1970	Standard Error*	Mean % Correct 1973	Standard Error*	Mean Change**	Standard Error*
National	56.8	(0.4)	54.8	(0.5)	-2.0	(0.6)	70.3	(0.4)	68.7	(0.4)	-1.6	(0.6)	59.0	(0.5)	58.2	(0.7)	-0.8	(0.8)
Region																		
Northeast	59.5	(0.6)	57.1	(0.7)	-2.3	(0.9)	72.3	(0.6)	69.3	(0.5)	-3.0	(0.7)	60.6	(0.9)	60.5	(1.1)	-0.1	(1.5)
Southeast	50.7	(0.9)	50.5	(1.1)	-0.2	(1.4)	65.5	(1.0)	65.2	(1.0)	-0.3	(1.4)	55.0	(1.2)	53.6	(1.2)	-1.3	(1.7)
Central	58.3	(0.8)	55.9	(0.9)	-2.5	(1.2)	71.9	(0.7)	70.6	(1.0)	-1.2	(1.2)	60.2	(1.0)	59.7	(1.2)	-0.6	(1.6)
West	57.3	(1.0)	55.5	(1.0)	-1.8	(1.4)	70.1	(0.8)	69.2	(0.7)	-0.9	(1.1)	59.3	(0.9)	58.7	(1.6)	-0.6	(1.8)
Sex																		
Males	58.4	(0.4)	56.5	(0.5)	-1.9	(0.7)	71.1	(0.5)	69.4	(0.5)	-1.7	(0.6)	58.5	(0.6)	57.9	(0.7)	-0.6	(0.9)
Females	55.1	(0.5)	53.2	(0.5)	-2.0	(0.7)	69.3	(0.4)	67.9	(0.5)	-1.5	(0.6)	59.6	(0.6)	58.5	(0.7)	-1.0	(1.0)
Race																		
Whites	59.8	(0.4)	58.1	(0.4)	-1.7	(0.6)	73.1	(0.4)	71.5	(0.4)	-1.7	(0.6)	61.9	(0.6)	61.4	(0.6)	-0.6	(0.9)
Blacks	42.5	(0.9)	40.6	(0.6)	-1.8	(1.1)	56.4	(1.1)	57.1	(0.5)	0.7	(1.2)	45.5	(1.2)	44.6	(0.9)	-0.9	(1.5)
Other	46.2	(1.2)	46.7	(1.2)	0.6	(1.7)	59.8	(1.5)	60.4	(1.2)	0.6	(1.9)	46.9	(1.3)	50.4	(1.7)	3.5	(2.1)
Parental education																		
No high school	48.9	(1.1)	49.1	(1.0)	0.2	(1.5)	62.5	(1.2)	62.6	(1.0)	0.1	(1.5)	48.3	(1.8)	50.7	(1.7)	2.5	(2.5)
Some high school	51.1	(1.0)	50.9	(0.9)	-0.2	(1.4)	65.9	(1.1)	65.4	(1.1)	-0.4	(1.6)	51.9	(1.7)	55.6	(1.8)	3.7	(2.4)
Graduated high school	57.4	(0.6)	56.0	(0.6)	-1.5	(0.8)	70.6	(0.7)	69.6	(0.6)	-1.1	(0.9)	58.5	(0.8)	59.4	(0.9)	0.9	(1.2)
Post high school	62.8	(0.5)	60.8	(0.5)	-2.0	(0.7)	75.5	(0.5)	73.6	(0.5)	-1.9	(0.7)	66.1	(0.7)	64.3	(0.8)	-1.7	(1.1)
Unknown	52.5	(0.5)	50.7	(0.5)	-1.6	(0.8)	66.5	(0.6)	65.5	(0.5)	-1.0	(0.8)	54.5	(0.7)	53.9	(0.6)	-0.6	(0.9)
Size and type of Community																		
Extreme rural	51.1	(1.3)	52.1	(1.2)	1.0	(1.8)	64.4	(2.2)	66.0	(0.9)	1.7	(2.4)	52.8	(2.9)	53.7	(1.8)	0.9	(3.4)
Low metro	42.0	(1.3)	41.0	(0.9)	-1.0	(1.6)	55.5	(1.5)	56.2	(1.0)	0.8	(1.8)	43.6	(1.4)	44.2	(1.2)	0.6	(1.8)
High metro	65.2	(1.4)	62.4	(0.9)	-2.9	(1.6)	77.3	(0.9)	74.4	(1.0)	-2.9	(1.3)	67.9	(1.4)	66.2	(1.5)	-1.7	(2.1)
Main big city	54.2	(1.2)	53.2	(1.4)	-1.0	(1.8)	68.2	(1.1)	67.3	(1.3)	-0.9	(1.6)	58.3	(1.5)	56.9	(1.7)	-1.3	(2.3)
Urban fringe	59.6	(1.0)	56.2	(0.9)	-3.4	(1.3)	71.1	(0.9)	69.9	(1.1)	-1.2	(1.4)	61.1	(1.9)	61.6	(1.6)	0.5	(2.5)
Medium city	57.5	(0.9)	56.1	(1.3)	-1.4	(1.6)	71.7	(1.2)	70.1	(1.1)	-1.6	(1.6)	61.2	(1.5)	60.3	(1.8)	-0.8	(2.2)
Small places	58.1	(0.7)	55.7	(0.9)	-2.4	(1.2)	71.8	(0.7)	69.7	(0.7)	-2.1	(1.0)	59.1	(0.9)	58.1	(1.1)	-1.1	(1.5)

NOTE: Number of exercises is in parentheses.

**All standard errors in this table are rounded figures. The standard error of change is calculated from the 1969-70 standard error (SE_1) and the 1971-73 standard error (SE_2) using the formula $\sqrt{SE_1^2 + SE_2^2}$.*

***The mean change is the mean of the changes in performance for the exercises. The mean change is equal to the difference in the means of each year, but may differ in this chart due to rounding.*

TABLE B-6. Mean Changes in Performance by 1969-70 Science Objectives: Age 9, 1970-73

	Objective I (58)						Objective II (21)						Objective III (8)						Objective IV (5)					
	Mean % Correct 1970	Standard Error*	Mean % Correct 1973	Standard Error*	Mean Change**	Standard Error*	Mean % Correct 1970	Standard Error*	Mean % Correct 1973	Standard Error*	Mean Change**	Standard Error	Mean % Correct 1970	Standard Error*	Mean % Correct 1973	Standard Error*	Mean Change**	Standard Error*	Mean % Correct 1970	Standard Error*	Mean % Correct 1973	Standard Error*	Mean Change**	Standard Error*
National	61.4	(0.4)	59.0	(0.5)	-2.3	(0.6)	63.6	(0.6)	63.4	(0.5)	-0.2	(0.7)	44.3	(0.7)	41.3	(0.8)	-3.0	(1.1)	74.9	(0.7)	76.8	(0.7)	1.9	(0.9)
Region																								
Northeast	63.1	(0.6)	60.6	(0.7)	-2.6	(0.9)	67.2	(0.7)	65.5	(0.6)	-1.8	(0.9)	45.3	(1.3)	43.9	(1.4)	-1.5	(1.9)	77.5	(1.1)	79.4	(1.1)	1.9	(1.5)
Southeast	55.9	(0.8)	55.2	(1.1)	-0.7	(1.4)	57.2	(1.6)	58.7	(1.0)	1.5	(1.8)	42.7	(1.6)	37.3	(1.3)	-5.4	(2.1)	68.6	(1.5)	71.8	(1.4)	3.2	(2.0)
Central	62.6	(0.6)	60.1	(0.9)	-2.5	(1.1)	66.4	(1.1)	65.7	(1.1)	-0.7	(1.6)	45.1	(1.2)	42.4	(1.5)	-2.7	(1.9)	75.2	(1.4)	78.2	(1.4)	3.1	(1.9)
West	62.4	(0.8)	59.9	(0.9)	-2.4	(1.2)	61.6	(1.2)	63.2	(0.9)	1.5	(1.5)	43.4	(1.5)	41.3	(2.1)	-2.1	(2.5)	77.2	(1.2)	77.5	(1.5)	0.3	(1.9)
Sex																								
Males	62.9	(0.4)	60.8	(0.5)	-2.1	(0.6)	64.4	(0.6)	63.4	(0.5)	-1.0	(0.8)	43.3	(0.8)	40.7	(1.0)	-2.6	(1.2)	75.1	(0.6)	77.3	(0.8)	2.2	(1.1)
Females	59.8	(0.4)	57.3	(0.5)	-2.5	(0.6)	62.7	(0.7)	63.4	(0.5)	0.6	(0.9)	45.4	(0.8)	42.0	(0.9)	-3.4	(1.2)	74.7	(0.9)	76.3	(0.8)	1.6	(1.2)
Race																								
Whites	64.2	(0.4)	62.1	(0.4)	-2.1	(0.5)	67.0	(0.5)	66.7	(0.5)	-0.3	(0.7)	47.0	(0.8)	44.4	(0.8)	-2.6	(1.2)	77.7	(0.8)	80.2	(0.7)	2.5	(1.0)
Blacks	47.3	(0.9)	45.9	(0.5)	-1.4	(1.0)	47.7	(1.1)	49.6	(0.5)	1.9	(1.2)	32.9	(1.8)	28.7	(1.1)	-4.2	(2.1)	62.5	(1.9)	61.4	(1.5)	-0.9	(2.5)
Other	51.7	(1.1)	51.5	(1.0)	-0.4	(1.5)	50.5	(1.7)	54.2	(1.8)	3.7	(2.5)	51.5	(1.6)	52.4	(1.6)	0.9	(3.5)	62.7	(2.0)	70.0	(1.9)	7.3	(2.8)
Parental education																								
No high school	53.5	(1.0)	55.2	(1.0)	-0.3	(1.4)	55.5	(1.6)	57.7	(1.2)	2.2	(2.0)	35.1	(1.9)	33.0	(2.0)	-2.1	(2.8)	61.2	(2.5)	68.9	(2.4)	7.7	(3.5)
Some high school	56.1	(1.0)	55.4	(1.0)	-0.7	(1.4)	58.4	(1.1)	59.8	(1.1)	1.5	(1.5)	35.8	(2.1)	36.7	(1.9)	0.9	(2.8)	69.2	(2.6)	77.1	(2.2)	7.9	(3.4)
Graduated high school	61.7	(0.5)	60.1	(0.5)	-1.6	(0.7)	64.6	(0.7)	64.8	(0.6)	0.2	(0.9)	44.0	(1.1)	42.5	(1.1)	-1.4	(1.5)	74.0	(1.0)	76.4	(1.2)	2.4	(1.6)
Post high school	66.9	(0.4)	64.5	(0.5)	-2.3	(0.7)	70.0	(0.7)	69.1	(0.6)	-0.8	(0.9)	51.4	(1.0)	48.5	(1.1)	-3.2	(1.5)	81.5	(0.9)	82.3	(0.9)	0.8	(1.3)
Unknown	57.4	(0.5)	55.3	(0.5)	-2.1	(0.7)	58.4	(0.8)	59.2	(0.6)	0.8	(1.0)	39.7	(0.8)	36.7	(0.8)	-3.1	(1.1)	71.4	(1.1)	73.7	(0.8)	2.3	(1.4)
Size and type of Community																								
Extreme rural	55.9	(1.4)	57.1	(1.0)	1.2	(1.7)	57.5	(2.8)	58.2	(1.7)	0.9	(3.4)	37.3	(3.2)	37.0	(2.1)	-0.1	(3.8)	68.2	(3.2)	72.4	(2.0)	4.2	(3.8)
Low metro	46.9	(1.4)	46.0	(0.8)	-0.9	(1.6)	47.6	(1.7)	49.6	(1.1)	2.0	(2.0)	29.7	(1.8)	26.1	(1.7)	-3.6	(2.5)	58.7	(1.8)	63.1	(1.5)	4.4	(2.3)
High metro	69.4	(1.0)	65.6	(0.9)	-3.7	(1.3)	71.1	(1.5)	71.1	(0.9)	0.0	(1.7)	53.7	(2.7)	49.8	(2.1)	-3.9	(3.4)	84.1	(1.6)	84.4	(1.6)	0.4	(2.4)
Main big city	58.9	(1.1)	57.6	(1.2)	-1.2	(1.6)	61.4	(1.4)	61.4	(1.4)	-0.0	(2.0)	42.4	(2.0)	40.5	(2.5)	-1.9	(3.0)	76.0	(1.8)	74.8	(1.7)	-1.2	(2.5)
Urban fringe	63.4	(0.9)	60.0	(1.0)	-3.4	(1.5)	66.2	(1.1)	66.0	(1.5)	-0.1	(1.7)	45.4	(1.9)	43.5	(1.8)	-1.9	(2.6)	77.5	(2.1)	81.5	(1.2)	4.0	(2.6)
Medium city	62.4	(0.9)	60.1	(1.3)	-2.3	(1.5)	64.2	(1.4)	65.9	(1.2)	1.7	(1.8)	46.8	(1.9)	42.9	(2.1)	-3.9	(2.8)	77.5	(1.5)	78.7	(1.2)	1.2	(1.9)
Small places	62.7	(0.6)	60.0	(0.8)	-2.7	(1.0)	64.9	(1.0)	63.9	(0.8)	-1.1	(1.3)	45.1	(1.4)	41.4	(1.5)	-3.7	(2.1)	74.3	(1.0)	76.9	(1.0)	2.7	(1.4)

NOTE: Number of exercises is in parentheses.

All standard errors in this table are rounded figures. The standard error of change is calculated from the 1969-70 standard error (SE_1) and the 1972-73 standard error (SE_2) using the formula $\sqrt{SE_1^2 + SE_2^2}$.

**The mean change is the mean of the changes in performance for the exercises. The mean change is equal to the difference in the means of each year, but may differ in this chart due to rounding.

TABLE B-7. Mean Changes in Performance by 1972-73 Science Objectives: Age 9, 1970-73

	Objective I (40)						Objective II (47)						Objective III (5)					
	Mean % Correct 1970	Standard Error*	Mean % Correct 1973	Standard Error*	Mean Change**	Standard Error*	Mean % Correct 1970	Standard Error*	Mean % Correct 1973	Standard Error*	Mean Change**	Standard Error*	Mean % Correct 1970	Standard Error*	Mean % Correct 1973	Standard Error*	Mean Change**	Standard Error*
National	66.6	(0.3)	64.1	(0.5)	-2.4	(0.6)	55.0	(0.5)	53.6	(0.5)	-1.4	(0.7)	74.9	(0.7)	76.8	(0.7)	1.9	(0.9)
Region																		
Northeast	68.2	(0.5)	65.4	(0.8)	-2.8	(1.0)	57.9	(0.7)	55.8	(0.7)	-2.1	(1.0)	77.5	(1.1)	79.4	(1.1)	1.9	(1.5)
Southeast	61.4	(0.8)	60.5	(1.2)	-0.9	(1.4)	49.6	(1.1)	49.2	(1.0)	-0.4	(1.5)	68.6	(1.5)	71.8	(1.4)	3.2	(2.0)
Central	67.8	(0.7)	65.4	(1.0)	-2.3	(1.2)	56.9	(0.9)	55.1	(1.0)	-1.9	(1.3)	75.2	(1.4)	78.2	(1.4)	3.1	(1.9)
West	67.7	(0.8)	64.9	(0.9)	-2.7	(1.2)	54.3	(0.9)	54.0	(1.0)	-0.4	(1.3)	77.2	(1.2)	77.5	(1.5)	0.3	(1.9)
Sex																		
Males	67.8	(0.4)	65.7	(0.5)	-2.1	(0.6)	56.0	(0.5)	54.3	(0.5)	-1.7	(0.7)	75.1	(0.8)	77.3	(0.8)	2.2	(1.1)
Females	65.3	(0.4)	62.6	(0.5)	-2.7	(0.6)	54.0	(0.5)	52.9	(0.5)	-1.1	(0.7)	74.7	(0.9)	76.3	(0.8)	1.6	(1.2)
Race																		
Whites	69.4	(0.3)	67.2	(0.4)	-2.3	(0.6)	58.0	(0.5)	56.8	(0.5)	-1.3	(0.6)	77.7	(0.8)	80.2	(0.7)	2.5	(1.0)
Blacks	52.3	(0.8)	51.1	(0.6)	-1.2	(1.0)	40.8	(0.9)	40.1	(0.4)	-0.6	(1.0)	62.3	(1.9)	61.4	(1.3)	-0.9	(2.3)
Other	56.5	(1.2)	56.3	(1.3)	-0.2	(1.8)	43.6	(1.1)	45.1	(1.3)	1.4	(1.7)	62.7	(2.0)	70.0	(1.9)	7.3	(2.8)
Parental education																		
No high school	58.2	(1.0)	57.8	(1.2)	-0.4	(1.6)	47.3	(1.3)	47.8	(0.9)	0.6	(1.6)	61.2	(2.5)	68.9	(2.4)	7.7	(3.5)
Some high school	61.7	(1.0)	60.1	(1.1)	-1.6	(1.5)	48.9	(1.0)	50.1	(0.9)	1.2	(1.3)	69.2	(2.6)	77.1	(2.2)	7.9	(3.4)
Graduated high school	67.0	(0.6)	65.3	(0.6)	-1.7	(0.8)	55.4	(0.6)	54.7	(0.5)	-0.7	(0.8)	74.0	(1.0)	76.4	(1.2)	2.4	(1.6)
Post high school	72.1	(0.4)	69.5	(0.6)	-2.6	(0.7)	61.2	(0.6)	59.6	(0.6)	-1.6	(0.8)	81.5	(0.9)	82.3	(0.9)	0.8	(1.3)
Unknown	62.3	(0.5)	60.5	(0.5)	-1.8	(0.7)	50.6	(0.6)	49.5	(0.5)	-1.1	(0.8)	71.4	(1.1)	73.7	(0.8)	2.3	(1.4)
Size and type of Community																		
Extreme rural	61.2	(1.6)	62.4	(1.1)	1.2	(2.0)	48.8	(1.6)	49.7	(1.4)	0.8	(2.1)	68.2	(3.2)	72.4	(2.0)	4.2	(3.8)
Low metro	51.6	(1.4)	51.1	(0.9)	-0.5	(1.7)	40.3	(1.2)	39.9	(0.8)	-0.4	(1.4)	58.7	(1.8)	63.1	(1.5)	4.4	(2.3)
High metro	74.0	(1.2)	70.7	(1.1)	-3.3	(1.6)	63.5	(1.1)	61.1	(1.3)	-2.4	(1.4)	84.1	(1.8)	84.4	(1.6)	0.4	(2.4)
Main big city	64.8	(1.0)	62.5	(1.4)	-2.3	(1.7)	52.2	(1.4)	52.3	(1.2)	0.1	(1.9)	76.0	(1.8)	74.8	(1.7)	-1.2	(2.5)
Urban fringe	68.8	(0.9)	65.0	(1.1)	-3.7	(1.4)	57.0	(0.8)	55.6	(0.9)	-1.4	(1.5)	77.3	(2.3)	81.3	(1.2)	4.0	(2.6)
Medium city	67.9	(0.7)	65.0	(1.3)	-2.9	(1.5)	55.9	(1.0)	55.6	(1.4)	-0.3	(1.7)	77.5	(1.5)	78.7	(1.2)	1.2	(1.9)
Small places	67.8	(0.5)	65.2	(0.7)	-2.6	(0.9)	56.3	(0.8)	54.1	(0.9)	-2.2	(1.2)	74.3	(1.0)	76.9	(1.0)	2.7	(1.4)

NOTE: Number of exercises is in parentheses.

**All standard errors in this table are rounded figures. The standard error of change is calculated from the 1969-70 standard error (SE_1) and the 1972-73 standard error (SE_2) using the formula $\sqrt{SE_1^2 + SE_2^2}$.*

***The mean change is the mean of the changes in performance for the exercises. The mean change is equal to the difference in the means of each year, but may differ in this chart due to rounding.*

TABLE B-8. Mean Changes in Performance by Type of Science: Age 13, 1969-72

	Physical Science (36)						Biological Science (23)						Unclassified (8)					
	Mean % Correct 1969	Standard Error*	Mean % Correct 1972	Standard Error*	Mean Change**	Standard Error*	Mean % Correct 1969	Standard Error*	Mean % Correct 1972	Standard Error*	Mean Change**	Standard Error*	Mean % Correct 1969	Standard Error*	Mean % Correct 1972	Standard Error*	Mean Change**	Standard Error*
National	59.7	(0.5)	57.0	(0.5)	-2.7	(0.7)	59.4	(0.5)	58.0	(0.5)	-1.4	(0.7)	64.8	0.6	65.3	0.6	0.5	0.9
Region																		
Northeast	61.9	(0.9)	59.3	(0.9)	-2.6	(1.3)	60.8	(0.9)	60.2	(1.1)	-0.6	(1.4)	66.1	1.1	68.3	1.1	2.2	1.5
Southeast	54.4	(1.1)	54.2	(1.2)	-0.2	(1.6)	54.8	(1.2)	55.0	(0.8)	0.2	(1.4)	59.5	1.3	62.1	1.1	2.8	1.7
Central	62.2	(0.8)	58.3	(1.2)	-3.9	(1.5)	61.4	(1.1)	59.5	(0.9)	-1.9	(1.4)	68.1	1.2	67.9	1.3	-0.2	1.7
West	59.0	(0.7)	55.9	(0.9)	-3.1	(1.2)	59.5	(0.7)	56.7	(1.1)	-2.8	(1.3)	64.4	1.2	62.1	1.5	-2.3	1.9
Sex																		
Males	63.1	(0.5)	60.2	(0.6)	-2.9	(0.8)	60.0	(0.6)	59.3	(0.6)	-0.8	(0.8)	65.6	0.6	65.0	0.8	-0.5	1.0
Females	56.4	(0.5)	53.8	(0.6)	-2.6	(0.8)	58.8	(0.6)	56.7	(0.5)	-2.2	(0.8)	64.1	0.9	65.5	0.7	1.4	1.1
Race																		
Whites	63.1	(0.4)	60.5	(0.5)	-2.6	(0.6)	62.6	(0.5)	61.5	(0.5)	-1.2	(0.7)	68.0	0.7	68.8	0.6	0.8	0.9
Blacks	44.1	(0.8)	39.7	(0.7)	-4.4	(1.1)	44.2	(0.6)	41.9	(0.9)	-2.3	(1.1)	50.6	1.2	50.0	1.2	-0.6	1.6
Other	49.1	(1.3)	47.1	(1.3)	-2.0	(1.8)	49.3	(1.2)	46.1	(1.4)	-3.1	(1.8)	52.9	1.5	51.5	2.3	-1.2	2.7
Parental education																		
No high school	47.7	(1.1)	48.5	(1.1)	0.8	(1.5)	48.5	(1.2)	49.1	(1.4)	0.5	(1.8)	54.3	2.1	54.9	1.8	0.6	2.8
Some high school	51.9	(1.1)	50.5	(0.9)	-1.4	(1.4)	53.0	(1.1)	52.5	(1.0)	-0.6	(1.4)	58.2	1.3	59.1	1.5	0.9	1.9
Graduated high school	57.9	(0.6)	56.8	(0.5)	-1.1	(0.8)	57.7	(0.6)	57.7	(0.6)	-0.0	(0.8)	63.2	1.0	65.4	0.8	2.2	1.3
Post high school	65.5	(0.5)	63.4	(0.5)	-2.1	(0.7)	64.6	(0.6)	64.5	(0.5)	-0.1	(0.8)	70.1	0.8	72.7	0.7	2.6	1.0
Unknown	52.2	(1.4)	47.3	(0.8)	-4.8	(1.6)	50.8	(1.1)	48.3	(0.8)	-2.6	(1.3)	55.9	1.5	53.1	1.3	-2.8	2.0
Size and type of Community																		
Extreme rural	52.3	(2.1)	54.9	(1.5)	2.6	(2.6)	53.9	(1.6)	56.1	(1.4)	2.2	(2.1)	61.9	1.8	62.1	2.1	0.2	2.8
Low metro	46.4	(1.5)	43.4	(1.7)	-3.0	(2.2)	46.8	(1.2)	44.6	(1.6)	-2.2	(2.0)	52.0	2.0	52.1	2.4	0.1	3.2
High metro	66.4	(1.1)	64.8	(1.0)	-1.6	(1.5)	65.5	(1.1)	63.2	(1.3)	-2.3	(1.7)	70.7	1.8	74.6	1.5	4.0	2.3
Main big city	57.8	(1.6)	54.5	(1.2)	-3.4	(2.0)	56.0	(1.6)	55.4	(1.3)	-0.6	(2.0)	63.4	1.6	63.0	1.5	-0.3	2.2
Urban fringe	63.5	(1.3)	57.4	(1.0)	-6.1	(1.7)	61.2	(0.9)	59.2	(1.1)	-1.9	(1.4)	67.5	1.8	66.4	1.5	-1.1	2.4
Medium city	61.0	(1.2)	58.3	(1.7)	-2.7	(2.1)	61.3	(1.2)	59.4	(1.4)	-1.9	(1.8)	65.0	2.1	65.2	1.8	0.2	2.8
Small places	60.9	(0.7)	58.1	(0.7)	-2.9	(1.0)	60.9	(0.8)	59.7	(0.9)	-1.3	(1.2)	65.8	1.0	66.5	1.0	0.8	1.4

NOTE: Number of exercises is in parentheses.

**All standard errors in this table are rounded figures. The standard error of change is calculated from the 1969-70 standard error (SE_1) and the 1972-73 standard error (SE_2) using the formula $\sqrt{SE_1^2 + SE_2^2}$.*

***The mean change is the mean of the changes in performance for the exercises. The mean change is equal to the difference in the means of each year, but may differ in this chart due to rounding.*

TABLE B-9. Mean Changes in Performance by 1969-70 Science Objectives: Age 13, 1969-72

	Objective I (50)						Objective II (9)						Objective III (5)						Objective IV (5)					
	Mean % Correct 1969	Standard Error*	Mean % Correct 1972	Standard Error*	Mean Change**	Standard Error*	Mean % Correct 1969	Standard Error*	Mean % Correct 1972	Standard Error*	Mean Change**	Standard Error*	Mean % Correct 1969	Standard Error*	Mean % Correct 1972	Standard Error*	Mean Change**	Standard Error*	Mean % Correct 1969	Standard Error*	Mean % Correct 1972	Standard Error*	Mean Change**	Standard Error*
National	56.5	(0.5)	54.3	(0.5)	-2.2	(0.6)	71.7	(0.6)	69.0	(0.8)	-2.7	(1.0)	68.5	(0.7)	68.1	(0.7)	-0.2	(1.0)	74.4	(0.9)	77.4	(0.7)	3.0	(1.2)
Region																								
Northeast	58.2	(0.8)	56.3	(0.9)	-2.0	(1.2)	74.7	(1.5)	73.	(0.9)	-1.5	(1.7)	68.9	(1.1)	70.2	(1.5)	1.5	(1.8)	75.3	(2.0)	80.4	(1.3)	5.0	(2.4)
Southeast	51.5	(1.2)	51.6	(0.9)	0.1	(1.5)	65.6	(1.4)	64.	(1.6)	-0.8	(2.1)	65.9	(1.2)	66.3	(1.1)	2.4	(1.7)	69.5	(1.7)	72.8	(1.4)	3.5	(2.2)
Central	59.0	(0.9)	55.6	(1.0)	-3.4	(1.3)	73.0	(0.9)	71.6	(1.7)	-1.4	(1.9)	71.7	(1.4)	70.0	(1.4)	-1.7	(2.0)	77.1	(1.5)	79.9	(1.3)	2.8	(2.0)
West	55.9	(0.7)	53.3	(0.8)	-2.6	(1.1)	72.2	(0.9)	65.8	(1.6)	-6.4	(1.8)	67.8	(1.6)	65.5	(1.6)	-2.2	(2.7)	74.2	(2.2)	75.6	(1.7)	1.4	(2.8)
Sex																								
Males	58.9	(0.5)	56.9	(0.5)	-2.0	(0.7)	74.1	(0.7)	71.0	(0.8)	-3.1	(1.1)	67.1	(0.8)	66.2	(0.8)	-0.9	(1.1)	76.1	(1.2)	78.3	(1.0)	2.2	(1.6)
Females	54.1	(0.6)	51.9	(0.5)	-2.3	(0.7)	69.4	(0.7)	67.2	(0.9)	-2.2	(1.1)	69.6	(1.0)	69.9	(0.9)	0.4	(1.3)	72.9	(1.2)	76.4	(0.9)	3.5	(1.5)
Race																								
Whites	59.8	(0.4)	57.7	(0.4)	-2.1	(0.6)	75.9	(0.5)	73.4	(0.7)	-2.5	(0.8)	71.2	(0.8)	71.6	(0.7)	0.4	(1.0)	76.4	(1.1)	79.8	(0.8)	3.4	(1.3)
Blacks	41.2	(0.6)	37.8	(0.6)	-3.4	(0.9)	52.7	(1.4)	47.9	(1.1)	-4.9	(1.8)	55.1	(1.7)	53.1	(1.3)	-2.0	(2.1)	66.4	(2.7)	68.7	(1.8)	2.3	(3.2)
Other	46.6	(1.5)	43.8	(1.1)	-2.7	(1.7)	59.3	(1.8)	56.3	(2.5)	-2.9	(3.1)	57.1	(1.8)	53.2	(2.9)	-3.9	(3.4)	68.5	(2.7)	68.1	(3.3)	-0.3	(4.0)
Parental education																								
No high school	45.0	(0.9)	45.6	(1.0)	0.6	(1.3)	56.8	(1.8)	60.0	(1.8)	3.1	(2.6)	60.5	(2.8)	57.7	(2.4)	-2.8	(3.7)	67.4	(3.4)	67.9	(2.6)	0.5	(4.3)
Some high school	48.8	(0.9)	47.9	(0.8)	-0.9	(1.2)	65.4	(1.6)	62.8	(1.6)	-2.6	(2.2)	65.2	(1.7)	62.8	(1.8)	-0.4	(2.4)	69.9	(2.0)	75.6	(1.8)	5.7	(2.7)
Graduated high school	54.6	(0.5)	53.9	(0.5)	-0.8	(0.7)	70.1	(0.8)	69.5	(0.9)	-0.7	(1.2)	67.1	(1.1)	69.0	(1.0)	1.9	(1.5)	72.9	(1.5)	76.8	(1.2)	3.9	(1.9)
Post high school	62.0	(0.5)	60.8	(0.4)	-1.2	(0.7)	76.0	(0.6)	75.8	(0.8)	-2.2	(1.0)	72.9	(0.9)	74.8	(0.8)	1.9	(1.2)	78.5	(1.1)	83.4	(0.9)	4.8	(1.4)
Unknown	49.0	(1.1)	44.6	(0.7)	-4.5	(1.2)	60.7	(2.5)	57.7	(1.3)	-3.0	(2.8)	58.2	(2.2)	54.9	(1.5)	-3.	(2.6)	69.7	(3.5)	70.9	(1.6)	1.2	(3.9)
Size and type of community																								
Extreme rural	49.9	(1.9)	52.4	(1.3)	2.5	(2.3)	64.3	(2.2)	66.0	(3.0)	1.8	(3.8)	65.8	(2.0)	63.8	(2.7)	-2.1	(3.4)	71.8	(4.1)	75.8	(2.7)	4.1	(4.9)
Low metro	43.5	(1.1)	40.7	(1.4)	-2.8	(1.8)	56.5	(2.6)	54.4	(1.7)	-2.0	(3.1)	55.7	(2.3)	54.7	(2.4)	-0.9	(3.4)	67.0	(3.3)	69.4	(3.4)	2.4	(4.8)
High metro	62.8	(1.1)	60.7	(0.7)	-2.1	(1.3)	80.0	(1.5)	79.1	(1.4)	-0.9	(2.1)	72.2	(2.3)	75.5	(2.1)	3.3	(3.1)	79.8	(2.1)	85.3	(2.1)	5.5	(3.0)
Main big city	53.9	(1.4)	51.8	(1.0)	-2.1	(1.7)	69.9	(2.2)	65.4	(2.1)	-4.5	(3.1)	66.9	(1.6)	66.6	(2.0)	-0.3	(2.5)	73.2	(3.6)	76.5	(3.2)	3.3	(4.8)
Urban fringe	59.6	(1.9)	55.5	(0.9)	-4.1	(1.4)	74.9	(1.5)	68.4	(1.4)	-6.4	(2.1)	69.7	(1.8)	68.1	(1.7)	-1.6	(2.4)	77.0	(2.5)	79.9	(2.1)	2.9	(3.2)
Medium city	57.9	(1.2)	55.7	(1.4)	-2.2	(1.8)	73.7	(1.6)	69.9	(2.2)	-3.7	(2.8)	68.8	(2.2)	69.0	(2.1)	0.1	(3.1)	74.4	(3.0)	76.0	(2.2)	1.6	(3.7)
Small places	57.8	(0.6)	55.4	(0.7)	-2.4	(1.0)	72.9	(0.9)	71.1	(1.0)	-1.8	(1.3)	69.8	(1.2)	70.5	(1.2)	0.8	(1.7)	77.	(1.8)	77.7	(1.1)	2.6	(2.1)

NOTE: Number of asterisks is to nonresponse.

*All standard errors in this table are rounded figures. The standard error of change is calculated from the 1969-70 standard error (SE_1) and the 1971-72 standard error (SE_2) using the formula $\sqrt{SE_1^2 + SE_2^2}$.

**The mean change is the mean of the changes in performance for the exercises. The mean change is equal to the difference in the means of each year, but may differ in this chart due to rounding.

TABLE B-10. Mean Changes in Performance by 1972-73 Science Objectives: Age 13, 1969-72

	Objective I (57)						Objective II (28)						Objective III (2)					
	Mean % Correct 1969	Standard Error*	Mean % Correct 1972	Standard Error*	Mean Change**	Standard Error*	Mean % Correct 1969	Standard Error*	Mean % Correct 1972	Standard Error*	Mean Change**	Standard Error*	Mean % Correct 1969	Standard Error*	Mean % Correct 1972	Standard Error*	Mean Change**	Standard Error*
National	60.1	(0.5)	58.4	(0.5)	-1.7	(0.7)	59.9	(0.5)	57.5	(0.5)	-2.4	(0.7)	65.6	(1.2)	69.1	(1.0)	3.5	(1.5)
Region																		
Northeast	62.3	(0.9)	61.2	(1.0)	-1.1	(1.3)	61.2	(0.9)	59.0	(0.8)	-2.1	(1.2)	[illegible]7	(2.4)	73.9	(1.8)	6.2	(3.0)
Southeast	55.5	(1.3)	55.6	(1.0)	0.0	(1.6)	54.3	(1.2)	54.6	(1.1)	0.3	(1.6)	[illegible]8.5	(2.5)	63.2	(1.7)	4.7	(3.0)
Central	62.3	(0.8)	59.6	(1.0)	-2.7	(1.3)	62.6	(0.8)	59.4	(1.2)	-3.3	(1.4)	69.1	(1.9)	72.5	(1.7)	3.4	(2.6)
West	59.1	(0.7)	56.8	(0.9)	-2.3	(1.2)	60.3	(0.8)	56.4	(1.0)	-3.9	(1.3)	65.2	(2.8)	65.7	(2.2)	0.5	(3.5)
Sex																		
Males	62.0	(0.5)	60.3	(0.6)	-1.7	(0.8)	62.5	(0.5)	60.0	(0.6)	-2.6	(0.8)	67.0	(1.6)	70.2	(1.3)	3.2	(2.1)
Females	58.3	(0.5)	56.4	(0.6)	-1.9	(0.8)	57.5	(0.6)	55.1	(0.6)	-2.4	(0.8)	64.3	(1.4)	68.0	(1.1)	3.7	(1.8)
Race																		
Whites	63.4	(0.4)	61.8	(0.5)	-1.6	(0.6)	63.4	(0.4)	61.1	(0.4)	-2.3	(0.6)	68.3	(1.4)	72.3	(1.1)	4.0	(1.7)
Blacks	45.1	(0.6)	42.1	(0.7)	-2.9	(0.9)	44.0	(1.0)	40.0	(0.6)	-4.0	(1.2)	55.0	(3.5)	57.8	(2.0)	2.8	(4.0)
Other	49.4	(1.3)	47.7	(1.2)	-1.8	(1.8)	49.3	(1.3)	46.1	(1.6)	-3.2	(2.1)	57.2	(3.3)	57.0	(3.5)	-0.3	(4.8)
Parental education																		
No high school	47.9	(1.0)	49.6	(1.1)	1.7	(1.5)	49.6	(1.3)	48.7	(1.1)	-0.9	(1.7)	53.8	(4.8)	57.4	(3.5)	3.7	(5.8)
Some high school	52.4	(0.9)	51.8	(0.9)	-0.6	(1.3)	53.6	(1.2)	51.9	(0.9)	-1.7	(1.5)	58.3	(2.9)	64.0	(2.0)	5.7	(3.5)
Graduated high school	58.7	(0.5)	58.1	(0.5)	-0.5	(0.7)	57.8	(0.6)	57.4	(0.6)	-0.5	(0.8)	63.8	(1.8)	68.1	(1.7)	4.3	(2.4)
Post high school	65.5	(0.6)	65.1	(0.5)	-0.4	(0.8)	65.6	(0.5)	63.7	(0.5)	-1.9	(0.7)	71.9	(1.3)	77.2	(1.2)	5.4	(1.8)
Unknown	52.6	(1.3)	48.3	(0.7)	-4.3	(1.4)	51.2	(0.9)	47.5	(0.9)	-3.6	(1.3)	57.7	(4.8)	60.6	(2.2)	2.9	(5.2)
Size and type of community																		
Extreme rural	53.6	(1.9)	56.6	(1.4)	3.0	(2.4)	53.9	(1.7)	54.8	(1.5)	0.9	(2.2)	62.7	(5.3)	67.3	(3.0)	4.6	(6.1)
Low metro	47.6	(1.2)	44.5	(1.5)	-3.1	(1.9)	46.1	(1.3)	44.3	(1.4)	-1.8	(1.9)	54.8	(3.8)	58.6	(4.5)	3.9	(5.9)
High metro	66.7	(1.0)	64.8	(0.9)	-1.9	(1.3)	65.8	(1.2)	65.1	(1.0)	-0.7	(1.6)	74.5	(2.9)	80.4	(2.5)	5.9	(3.8)
Main big city	57.9	(1.4)	55.9	(1.2)	-1.9	(1.8)	57.4	(1.8)	54.8	(1.0)	-2.6	(2.0)	64.3	(5.0)	68.0	(4.3)	3.7	(6.6)
Urban fringe	63.4	(1.0)	59.4	(1.1)	-4.0	(1.5)	62.6	(1.4)	57.8	(0.9)	-4.8	(1.7)	68.7	(3.1)	72.4	(2.6)	3.7	(4.0)
Medium city	61.2	(1.2)	59.4	(1.6)	-1.7	(1.9)	61.9	(1.2)	59.1	(1.6)	-2.8	(2.0)	65.6	(3.9)	66.9	(3.2)	1.3	(5.0)
Small places	61.2	(0.6)	59.7	(0.8)	-1.5	(1.0)	61.5	(0.7)	58.8	(0.7)	-2.7	(1.0)	66.2	(2.4)	69.5	(1.7)	3.3	(2.9)

NOTE: Number of exercises is in parentheses.

All standard errors in this table are rounded figures. The standard error of change is calculated from the 1969-70 standard error (SE_1) and the 1972-73 standard error (SE_2) using the formula $\sqrt{SE_1^2 + SE_2^2}$.

The mean change is the mean of the changes in performance for the exercises. The mean change is equal to the difference in the means of each year, but may differ in this chart due to

TABLE B-11. Mean Changes in Performance by Type of Science: Age 17, 1969-73

	Physical Science (39)						Biological Science (20)						Unclassified (5)					
	Mean % Correct 1969	Standard Error*	Mean % Correct 1973	Standard Error*	Mean Change**	Standard Error*	Mean % Correct 1969	Standard Error*	Mean % Correct 1973	Standard Error*	Mean Change**	Standard Error*	Mean % Correct 1969	Standard Error*	Mean % Correct 1973	Standard Error*	Mean Change**	Standard Error*
National	43.2	(0.4)	39.2	(0.4)	-4.0	(0.5)	52.6	(0.4)	51.0	(0.5)	-1.6	(0.6)	35.7	(0.7)	32.0	(0.6)	-3.7	(0.9)
Region																		
Northeast	45.6	(0.8)	41.0	(0.6)	-4.6	(1.1)	54.7	(0.8)	53.5	(0.8)	-1.2	(1.1)	38.4	(1.3)	33.8	(1.5)	-4.6	(2.0)
Southeast	40.9	(0.8)	38.1	(0.7)	-2.8	(1.0)	48.1	(0.7)	48.8	(0.8)	0.7	(1.1)	30.5	(1.7)	29.1	(1.3)	-1.4	(2.1)
Central	43.0	(0.6)	38.8	(0.9)	-4.1	(1.1)	52.9	(0.7)	52.2	(1.0)	-0.7	(1.2)	35.6	(1.1)	32.8	(1.0)	-2.8	(1.5)
West	42.8	(0.7)	38.5	(0.7)	-4.2	(1.0)	53.3	(0.7)	48.6	(1.1)	-4.7	(1.3)	36.8	(1.4)	31.4	(1.2)	-5.4	(1.8)
Sex																		
Males	47.9	(0.5)	43.7	(0.5)	-4.1	(0.7)	53.2	(0.5)	51.2	(0.6)	-2.0	(0.8)	37.9	(0.9)	34.0	(0.9)	-4.0	(1.3)
Females	38.8	(0.4)	35.0	(0.4)	-3.8	(0.6)	52.1	(0.5)	50.9	(0.6)	-1.2	(0.8)	33.6	(0.9)	30.2	(0.9)	-3.4	(1.3)
Race																		
Whites	44.8	(0.4)	41.3	(0.4)	-3.4	(0.5)	54.2	(0.4)	53.2	(0.5)	-1.0	(0.6)	37.8	(0.7)	33.9	(0.7)	-4.0	(1.0)
Blacks	31.9	(0.9)	28.7	(0.8)	-3.2	(1.2)	41.1	(1.1)	40.9	(1.0)	-0.2	(1.5)	21.2	(1.3)	22.2	(1.5)	0.9	(1.9)
Other	38.7	(1.2)	30.4	(1.0)	-8.3	(1.6)	47.7	(2.8)	39.8	(1.9)	-7.9	(3.4)	32.3	(3.0)	23.5	(2.9)	-8.9	(4.2)
Parental education																		
No high school	35.5	(0.8)	32.5	(1.0)	-3.0	(1.2)	44.3	(1.1)	42.5	(1.2)	-1.9	(1.6)	24.6	(1.7)	24.6	(1.4)	0.0	(2.2)
Some high school	37.8	(0.7)	33.3	(0.8)	-4.6	(1.0)	48.2	(0.7)	45.2	(0.8)	-3.1	(1.0)	28.8	(1.6)	24.8	(1.4)	-4.1	(2.1)
Graduated high school	41.3	(0.5)	37.8	(0.5)	-3.6	(0.7)	51.2	(0.7)	50.4	(0.6)	-0.8	(0.9)	34.1	(1.0)	30.1	(0.8)	-4.0	(1.2)
Post high school	47.3	(0.4)	43.5	(0.5)	-3.7	(0.6)	56.2	(0.5)	55.2	(0.6)	-1.1	(0.8)	40.6	(0.9)	37.1	(1.0)	-3.5	(1.4)
Unknown	36.9	(2.0)	30.9	(1.3)	-6.0	(2.4)	43.6	(2.7)	42.4	(1.3)	-1.2	(3.0)	33.5	(5.3)	24.2	(2.0)	-9.3	(5.6)
Size and type of Community																		
Extreme rural	40.7	(1.3)	37.7	(1.1)	-3.0	(1.7)	46.3	(1.6)	49.1	(2.3)	2.8	(2.8)	30.7	(3.2)	30.2	(1.7)	-0.5	(3.6)
Low metro	35.6	(1.5)	30.7	(1.3)	-4.9	(2.0)	46.8	(1.7)	43.1	(1.7)	-3.7	(2.4)	29.4	(3.2)	25.2	(2.6)	-4.2	(4.1)
High metro	48.2	(1.0)	42.9	(1.5)	-5.4	(1.8)	58.1	(0.8)	56.4	(1.8)	-1.7	(2.0)	43.2	(4.1)	40.0	(2.7)	-3.2	(4.9)
Main big city	42.2	(1.0)	36.4	(1.2)	-5.9	(1.5)	52.4	(1.0)	48.7	(0.9)	-3.8	(1.3)	35.9	(1.5)	28.1	(3.0)	-7.8	(3.4)
Urban fringe	42.7	(0.9)	39.2	(1.2)	-3.6	(1.6)	54.8	(1.5)	51.0	(1.4)	-3.8	(2.0)	39.1	(2.1)	32.6	(2.6)	-6.6	(3.3)
Medium city	43.9	(1.2)	39.8	(1.2)	-4.2	(1.7)	54.5	(1.5)	51.2	(1.4)	-3.3	(2.0)	36.1	(1.8)	31.8	(2.2)	-4.3	(2.9)
Small places	44.3	(0.7)	40.7	(0.6)	-3.5	(0.9)	52.4	(0.8)	51.9	(0.6)	-0.5	(1.0)	35.8	(1.4)	31.6	(0.9)	-4.2	(1.6)

NOTE: Number of examinees is in parentheses.

**All standard errors in this table are rounded figures. The standard error of change is calculated from the 1969-70 standard error (SE_1) and the 1972-73 standard error (SE_2) using the formula $\sqrt{SE_1^2 + SE_2^2}$.*

***The mean change is the mean of the changes in performance for the examinees. The mean change is equal to the difference in the means of each year, but may differ in this chart due to rounding.*

TABLE B-12. Mean Changes in Performance by 1969-70 Science Objectives: Age 17, 1969-73

	Objective I (55)						Objective II (8)						Objective III (3)					
	Mean % Correct 1969	Standard Error*	Mean % Correct 1973	Standard Error*	Mean Change**	Standard Error*	Mean % Correct 1969	Standard Error*	Mean % Correct 1973	Standard Error*	Mean Change**	Standard Error*	Mean % Correct 1969	Standard Error*	Mean % Correct 1973	Standard Error*	Mean Change**	Standard Error*
National	46.9	(0.3)	43.9	(0.4)	-3.1	(0.5)	46.6	(0.6)	42.0	(0.6)	-4.5	(0.9)	18.7	(0.8)	16.1	(0.6)	-2.6	(1.0)
Region																		
Northeast	49.3	(0.8)	46.1	(0.6)	-3.2	(1.0)	48.7	(1.1)	43.5	(1.1)	-5.2	(1.5)	20.7	(1.3)	16.7	(1.6)	-4.0	(2.0)
Southeast	44.1	(0.6)	42.6	(0.6)	-1.5	(0.9)	41.1	(1.0)	38.7	(1.2)	-2.3	(1.6)	15.4	(1.1)	13.7	(1.0)	-1.6	(1.5)
Central	46.7	(0.5)	44.1	(0.8)	-2.6	(0.9)	47.8	(1.3)	42.1	(1.0)	-5.7	(1.6)	18.5	(1.6)	16.8	(1.2)	-1.7	(2.0)
West	46.9	(0.6)	42.2	(0.7)	-4.7	(0.9)	46.6	(1.2)	43.3	(1.6)	-3.4	(2.0)	19.4	(2.0)	16.5	(1.1)	-2.9	(2.3)
Sex																		
Males	50.1	(0.4)	46.9	(0.4)	-3.2	(0.6)	50.7	(0.8)	45.5	(0.9)	-5.2	(1.2)	20.0	(1.2)	17.3	(0.9)	-2.7	(1.5)
Females	44.0	(0.3)	41.1	(0.4)	-2.9	(0.5)	42.7	(0.8)	38.8	(0.7)	-3.9	(1.0)	17.4	(0.9)	15.1	(0.9)	-2.3	(1.3)
Race																		
Whites	48.5	(0.3)	46.0	(0.3)	-2.5	(0.5)	48.9	(0.7)	44.7	(0.7)	-4.2	(0.9)	20.0	(0.9)	16.9	(0.7)	-3.1	(1.1)
Blacks	35.9	(0.7)	33.8	(0.7)	-2.1	(1.0)	30.5	(1.4)	27.9	(1.2)	-2.6	(1.8)	8.7	(1.4)	11.1	(1.5)	2.4	(2.0)
Other	42.4	(1.2)	34.0	(1.1)	-8.5	(1.6)	40.4	(3.1)	31.6	(2.2)	-8.8	(3.8)	17.8	(3.6)	16.0	(3.3)	-1.8	(4.9)
Parental education																		
No high school	39.2	(0.8)	36.7	(0.8)	-2.5	(1.1)	34.2	(2.0)	31.0	(1.8)	-3.2	(2.7)	13.5	(2.1)	14.8	(2.1)	1.3	(3.0)
Some high school	42.2	(0.6)	38.2	(0.6)	-3.9	(0.8)	38.9	(1.1)	32.6	(1.3)	-6.3	(1.7)	12.8	(1.4)	12.7	(1.5)	-0.1	(2.0)
Graduated high school	45.3	(0.4)	42.9	(0.4)	-2.5	(0.5)	44.4	(1.0)	40.2	(0.8)	-4.2	(1.2)	16.7	(1.1)	13.1	(0.9)	-3.6	(1.4)
Post high school	50.7	(0.4)	47.9	(0.4)	-2.7	(0.6)	52.4	(0.7)	48.6	(0.8)	-3.8	(1.1)	22.3	(1.1)	19.4	(1.2)	-2.9	(1.6)
Unknown	40.1	(1.7)	35.8	(1.3)	-4.3	(2.2)	35.2	(2.9)	29.8	(1.7)	-5.4	(3.4)	24.2	(5.6)	13.6	(2.0)	-10.6	(6.0)
Size and type of Community																		
Extreme rural	43.3	(1.1)	42.6	(1.1)	-0.8	(1.5)	40.4	(2.4)	37.5	(1.4)	-2.9	(2.8)	15.9	(2.5)	16.2	(1.7)	0.2	(3.0)
Low metro	40.3	(1.2)	35.7	(1.4)	-4.5	(1.8)	36.6	(2.7)	31.3	(2.2)	-5.3	(3.4)	15.4	(3.5)	13.6	(2.2)	-1.7	(4.1)
High metro	52.0	(0.8)	47.9	(1.2)	-4.0	(1.4)	53.6	(2.4)	49.3	(1.6)	-4.3	(2.9)	25.1	(4.0)	21.6	(2.3)	-3.6	(4.6)
Main big city	46.2	(0.8)	41.2	(0.9)	-5.0	(1.2)	45.1	(1.4)	39.5	(2.7)	-5.6	(3.0)	22.0	(1.8)	11.4	(1.5)	-10.6	(2.3)
Urban fringe	47.2	(0.9)	44.0	(1.1)	-3.2	(1.4)	49.4	(3.1)	40.7	(2.1)	-8.7	(3.7)	21.2	(3.4)	18.5	(1.5)	-2.8	(3.7)
Medium city	47.9	(1.0)	44.1	(1.1)	-3.8	(1.5)	49.1	(1.7)	43.3	(1.6)	-5.8	(2.3)	17.1	(2.0)	16.2	(2.1)	-0.9	(3.0)
Small places	47.6	(0.7)	45.2	(0.6)	-2.4	(0.9)	47.2	(1.1)	43.5	(0.8)	-3.7	(1.4)	17.8	(1.5)	14.7	(1.1)	-3.1	(1.8)

NOTE: Number of exercises is in parentheses.

**All standard errors in this table are rounded figures. The standard error of change is calculated from the 1969-70 standard error (SE_1) and the 1972-73 standard error (SE_2) using the formula $\sqrt{SE_1^2 + SE_2^2}$.*

***The mean change is the mean of the changes in performance for the exercises. The mean change is equal to the difference in the means of each year, but may differ in this chart due to rounding.*

TABLE B-13. Mean Changes in Performance by 1972-73 Science Objectives: Age 17, 1969-73

	Objective I (34)						Objective II (30)					
	Mean % Correct 1969	Standard Error*	Mean % Correct 1973	Standard Error*	Mean Change**	Standard Error*	Mean % Correct 1969	Standard Error*	Mean % Correct 1973	Standard Error*	Mean Change**	Standard Error*
National	50.2	(0.3)	46.9	(0.4)	-3.4	(0.5)	40.3	(0.4)	37.2	(0.4)	-3.1	(0.5)
Region												
Northeast	52.6	(0.8)	49.0	(0.6)	-3.6	(1.0)	42.6	(0.8)	39.1	(0.6)	-3.5	(1.0)
Southeast	47.0	(0.8)	45.9	(0.7)	-1.1	(1.1)	37.1	(0.6)	35.0	(0.7)	-2.2	(0.9)
Central	50.4	(0.7)	47.6	(0.9)	-2.8	(1.1)	39.9	(0.7)	36.7	(0.9)	-3.2	(1.1)
West	49.9	(0.5)	44.3	(0.8)	-5.6	(0.9)	40.7	(0.8)	37.5	(0.9)	-3.2	(1.2)
Sex												
Males	52.9	(0.5)	49.5	(0.4)	-3.5	(0.6)	44.0	(0.5)	40.6	(0.6)	-3.4	(0.7)
Females	47.7	(0.4)	44.5	(0.5)	-3.2	(0.6)	36.8	(0.4)	34.0	(0.4)	-2.7	(0.6)
Race												
Whites	51.8	(0.4)	49.1	(0.4)	-2.7	(0.5)	41.9	(0.4)	39.2	(0.4)	-2.7	(0.6)
Blacks	38.7	(0.9)	36.2	(0.8)	-2.5	(1.2)	28.5	(0.8)	27.2	(0.6)	-1.3	(1.0)
Other	44.2	(1.3)	36.0	(1.3)	-8.2	(1.8)	37.4	(1.5)	29.2	(1.3)	-8.2	(2.0)
Parental education												
No high school	41.7	(1.0)	39.9	(0.9)	-1.8	(1.4)	32.5	(0.9)	29.4	(0.9)	-3.1	(1.3)
Some high school	45.2	(0.6)	41.4	(0.7)	-3.7	(0.9)	35.0	(0.7)	30.6	(0.8)	-4.4	(1.0)
Graduated high school	49.0	(0.5)	46.1	(0.5)	-2.8	(0.7)	38.1	(0.5)	35.5	(0.5)	-2.6	(0.7)
Post high school	53.9	(0.4)	50.7	(0.4)	-3.2	(0.6)	44.6	(0.5)	42.1	(0.5)	-2.5	(0.7)
Unknown	43.3	(1.6)	38.5	(1.5)	-4.9	(2.2)	33.5	(2.1)	28.9	(1.0)	-4.6	(2.4)
Size and type of Community												
Extreme rural	46.2	(1.1)	45.8	(1.1)	-0.4	(1.6)	36.5	(1.4)	34.9	(1.0)	-1.6	(1.7)
Low metro	42.9	(1.4)	38.0	(1.7)	-5.0	(2.2)	33.7	(1.5)	29.8	(1.2)	-3.9	(1.9)
High metro	54.6	(0.9)	50.1	(1.4)	-4.5	(1.7)	45.8	(0.7)	43.3	(1.1)	-3.5	(1.3)
Main big city	49.9	(1.0)	44.3	(1.1)	-5.6	(1.5)	39.3	(1.0)	34.2	(1.2)	-5.1	(1.6)
Urban fringe	50.9	(1.1)	47.1	(1.0)	-3.8	(1.5)	40.9	(1.3)	37.0	(1.2)	-3.9	(1.8)
Medium city	51.3	(1.3)	47.1	(1.0)	-4.2	(1.7)	41.4	(1.0)	37.8	(1.4)	-3.6	(1.7)
Small places	51.0	(0.8)	48.6	(0.7)	-2.5	(1.0)	40.6	(0.7)	37.8	(0.6)	-2.8	(0.9)

NOTE: Number of exercises is in parentheses.

**All standard errors in this table are rounded figures. The standard error of change is calculated from the 1969-70 standard error (SE_1) and the 1972-73 standard error (SE_2) using the formula $\sqrt{SE_1^2 + SE_2^2}$.*

***The mean change is the mean of the changes in performance for the exercises. The mean change is equal to the difference in the means of each year, but may differ in this chart due to rounding.*

APPENDIX C

ESTIMATED POPULATION PROPORTIONS OF REPORTING CATEGORIES BASED ON NATIONAL ASSESSMENT SAMPLES, 1969-70 AND 1972-73

The estimated population proportions shown in this appendix are based on the samples used in the two assessments. These tables show that there were slight variations in the estimated proportions in various categories from 1969-70 to 1972-73. For example, at age 9 in 1970 the estimated proportion of whites was .817, the estimated proportion of blacks was .120 and the estimated proportion classified as other was .063. In 1973, the nation's 9-year-olds were estimated to have these proportions of the three racial categories: .789 for whites, .144 for blacks and .067 for other.

The national average percentage correct, of course, reflects these proportions. In 1970, the average national percentage correct was a weighted combination of the average percentages correct for the three races, using the 1970 proportions as weights:

$$61.1\% = 64.1\% (.871) + 47.0\% (.120) + 50.3\% (.063).$$

In 1973 the average national percentage correct was a weighted combination of the average percentages correct, using the 1973 proportions as weights:

$$59.4\% = 62.6\% (.789) + 46.1\% (.144) + 51.3\% (.067).$$

Thus, the proportions have a great deal of effect on the national-average percentage correct.

If the estimated racial proportions of 1970 had been the same as those of 1973, the estimated average-national-percentage correct for 1970 would have been:

$$64.1\% (.789) + 47.0\% (.144) + 50.3\% (.067),$$

which equals 60.7%. Thus, if the racial proportions for 9-year-olds of 1970 had been identical to those of 1973, the national change would have been a mean decline of 1.3 percentage points.

Changing proportions also accounts for seemingly inconsistent change values for categories of respondents. In most cases, changes for categories of respondents center around the national-

change value; some changes are slightly lower, some slightly higher than the national change. However, consider the changes observed for black, white and other 9-year-olds: blacks declined an average of 0.9 percentage points; whites declined 1.5 percentage points; and others improved 1.1 percentage points. All 9-year-olds showed a decline larger than all of these: -1.7 percentage points. The data are accurate for the categories. It is the changing proportions of racial categories that affects the national change. As illustrated above, if the 1970 proportions had been the same as those of 1973, the average change would have been -1.3 percentage points, which appears to be more consistent with the category changes.

Although such adjustments to equate category proportions across assessment years could be made, it is not clear if one year's proportions (and if so, which year) or if an average of the two years' proportions should be used.

A variety of factors could have caused or contributed to changes in the proportions, such as changes in the definitions of categories and/or their implementation in the field, true changes in the population proportions and sampling fluctuations. Whether or not it is desirable to make adjustments in the estimated proportions would depend on the relative contributions of the various factors, which unfortunately are not known. The present report focuses on data without such adjustments.

TABLE C-1. Estimated Population Distributions of Reporting Groups: Science, 1969-70, Age 9

	Nat'l (%)	Region				Sex		Race			Parental Education					Size and Type of Community						
		NE	SE	C	W	M	F	B	WH	OTH	NHS	SHS	GHS	PHS	UNK	ER	LM	HM	MBC	UF	MC	SP
Region																						
Northeast	25.5	100.0	0.0	0.0	0.0	26.0	24.9	16.6	27.9	12.0	17.1	17.4	25.7	25.2	28.1	2.[illegible]	19.8	29.1	23.6	33.8	21.2	29.8
Southeast	20.7	0.0	100.0	0.0	0.0	20.0	21.5	44.9	18.4	4.4	35.0	33.5	22.7	17.7	18.3	34.8	14.1	10.5	16.0	5.9	25.2	27.6
Central	29.8	0.0	0.0	100.0	0.0	30.4	29.3	23.3	32.3	10.3	24.1	26.1	33.2	30.1	28.5	39.9	33.2	20.0	33.3	36.8	23.8	28.7
West	24.0	0.0	0.0	0.0	100.0	23.6	24.3	15.2	21.4	73.3	23.7	23.0	18.4	26.9	25.0	22.7	32.9	40.4	27.1	23.6	29.9	13.9
Sex																						
Male	51.1	52.2	49.3	52.0	50.4	100.0	0.0	49.8	51.3	51.3	54.2	51.6	50.5	53.2	48.8	49.9	49.3	52.1	51.5	50.5	51.3	51.4
Female	48.9	47.8	50.7	48.0	49.6	0.0	100.0	50.2	48.7	48.7	45.8	48.5	49.5	46.8	51.2	50.1	50.7	47.9	48.5	[illegible].5	48.7	48.7
Race																						
Black	12.0	7.8	26.0	9.4	7.6	11.7	12.3	100.0	0.0	0.0	16.4	13.3	12.4	8.1	15.0	20.8	51.3	2.6	14.3	6.8	9.6	7.8
White	81.7	89.2	72.6	88.4	73.1	82.0	81.4	0.0	100.0	0.0	70.1	75.3	83.0	87.3	77.6	65.5	22.3	94.0	76.3	88.9	86.6	89.8
Other	6.3	3.0	1.4	2.2	19.3	6.4	6.3	0.0	0.0	100.0	13.5	11.4	4.7	4.6	7.4	13.7	26.4	3.4	9.5	4.3	3.8	2.4
Parental education																						
No high school	4.5	3.0	7.7	3.7	4.5	4.8	4.2	6.2	3.9	9.7	100.0	0.0	0.0	0.0	0.0	8.7	5.6	1.5	4.0	3.1	3.8	5.4
Some high school	5.4	3.7	8.8	4.8	5.2	5.5	5.4	6.0	5.0	9.8	0.0	100.0	0.0	0.0	0.0	9.0	5.6	1.7	4.4	3.2	4.7	7.3
Graduated high school	23.3	23.6	25.5	26.0	17.9	23.1	23.6	24.1	23.7	17.2	0.0	0.0	100.0	0.0	0.0	31.1	16.7	13.8	21.7	21.9	22.8	27.4
Post high school	33.9	33.5	28.9	34.2	38.1	35.3	32.4	22.7	36.7	24.7	0.0	0.0	0.0	100.0	0.0	25.7	23.6	53.0	30.8	35.5	37.6	30.8
Unknown	32.9	36.2	29.1	31.4	34.3	31.4	34.4	41.0	31.2	38.6	0.0	0.0	0.0	0.0	100.0	27.6	48.5	30.0	39.2	36.4	31.2	29.1
Size and type of Community																						
Extreme rural	8.0	0.8	13.5	10.7	7.6	7.9	8.2	13.9	6.4	17.5	15.5	13.2	10.7	5.6	6.7	100.0	0.0	0.0	0.0	0.0	0.0	0.0
Low metro	6.5	5.1	4.5	7.3	9.0	6.3	6.8	28.0	.8	27.3	8.1	6.8	4.7	4.6	9.7	0.0	100.0	0.0	0.0	0.0	0.0	0.0
High metro	11.7	13.4	5.5	7.9	19.8	12.0	11.5	2.5	13.5	6.4	4.0	3.6	6.9	18.4	10.7	0.0	0.0	100.0	0.0	0.0	0.0	0.0
Main big city	12.4	11.5	9.6	13.9	14.0	12.5	12.3	14.7	11.6	18.6	10.9	10.1	11.5	11.3	14.8	0.0	0.0	0.0	100.0	0.0	0.0	0.0
Urban fringe	13.0	17.3	3.7	16.0	12.8	12.9	13.2	7.4	14.2	8.9	8.8	7.6	12.2	13.6	14.4	0.0	0.0	0.0	0.0	100.0	0.0	0.0
Medium city	13.1	10.9	15.9	10.4	16.3	13.1	13.0	10.5	13.9	7.9	10.9	11.4	12.8	14.5	12.4	0.0	0.0	0.0	0.0	0.0	100.0	0.0
Small places	35.2	41.1	46.9	33.8	20.5	35.3	35.0	22.9	38.6	13.5	41.8	47.4	41.2	32.0	31.2	0.0	0.0	0.0	0.0	0.0	0.0	100.0

TABLE C-2. Estimated Population Distributions of Reporting Groups: Science, 1972-73, Age 9

	Nat'l (%)	Region				Sex		Race			Parental Education					Size and Type of Community						
		NE	SE	C	W	M	F	B	WH	OTH	NHS	SHS	GHS	PHS	UNK	ER	LM	HM	MBC	UF	MC	SP
Region																						
Northeast	25.2	100.0	0.0	0.0	0.0	24.9	25.6	21.4	26.4	19.9	18.0	21.3	24.5	25.4	26.9	4.5	35.8	45.3	32.0	27.2	14.9	21.5
Southeast	23.7	0.0	100.0	0.0	0.0	23.6	23.8	43.2	21.8	3.4	34.1	32.3	23.4	19.7	24.7	48.7	8.3	2.5	20.2	10.0	38.3	29.7
Central	27.5	0.0	0.0	100.0	0.0	28.0	27.0	24.3	29.5	10.5	19.9	23.8	29.8	27.6	27.6	29.3	55.9	23.0	30.1	39.7	21.0	23.5
West	23.6	0.0	0.0	0.0	100.0	23.6	23.7	11.1	22.3	66.2	28.0	22.6	22.4	27.3	20.9	17.5	20.0	29.2	17.7	23.1	25.7	25.3
Sex																						
Male	50.1	49.4	49.9	51.1	50.0	100.0	0.0	46.5	50.9	48.4	53.1	55.9	50.7	52.5	46.9	48.1	46.3	52.2	49.6	49.8	50.1	50.1
Female	49.9	50.6	50.1	48.9	50.0	0.0	100.0	53.5	49.1	51.6	46.9	44.1	49.3	47.5	53.1	51.9	53.7	47.8	50.4	50.2	49.8	49.9
Race																						
Black	14.4	12.3	26.3	12.7	6.8	13.4	15.5	100.0	0.0	0.0	18.4	22.6	14.4	10.4	16.1	17.0	63.8	3.0	22.5	3.9	13.7	7.7
White	78.9	82.5	72.7	84.7	74.4	80.2	77.6	0.0	100.0	0.0	67.0	67.7	79.9	85.8	75.7	76.1	21.9	92.1	63.8	91.5	83.1	86.9
Other	6.7	5.3	1.0	2.6	18.8	6.5	6.9	0.0	0.0	100.0	14.6	9.8	5.7	3.9	8.1	7.0	14.3	4.9	13.7	4.6	3.2	5.4
Parental education																						
No high school	5.0	3.6	7.2	3.6	6.0	5.3	4.7	6.4	4.3	10.9	100.0	0.0	0.0	0.0	0.0	10.5	6.6	1.5	4.4	2.9	4.5	5.8
Some high school	4.4	3.7	6.0	3.8	4.2	4.9	3.9	6.9	3.8	6.4	0.0	100.0	0.0	0.0	0.0	5.6	5.2	2.3	4.4	3.5	3.5	5.4
Graduated high school	20.9	20.3	20.7	22.7	19.9	21.2	20.7	20.9	21.2	17.8	0.0	0.0	100.0	0.0	0.0	24.7	18.4	17.7	19.5	20.4	18.9	23.3
Post high school	30.6	30.8	25.4	30.6	35.4	32.0	29.1	22.1	33.2	17.6	0.0	0.0	0.0	100.0	0.0	22.4	19.0	47.9	27.4	33.2	34.5	27.4
Unknown	39.1	41.6	40.7	39.2	34.6	36.6	41.6	43.8	37.5	47.4	0.0	0.0	0.0	0.0	100.0	36.8	50.9	30.6	44.3	40.1	38.6	38.1
Size and type of Community																						
Extreme rural	8.9	1.6	18.2	9.5	6.6	8.5	9.2	10.4	8.5	9.2	18.5	11.2	10.5	6.5	8.3	100.0	0.0	0.0	0.0	0.0	0.0	0.0
Low metro	8.1	11.5	2.8	10.6	6.9	7.5	8.7	35.9	2.3	17.2	10.6	9.5	7.1	5.0	10.5	0.0	100.0	0.0	0.0	0.0	0.0	0.0
High metro	12.7	22.8	1.3	10.6	15.7	13.2	12.1	2.7	14.8	9.2	3.8	6.7	10.7	19.8	9.9	0.0	0.0	100.0	0.0	0.0	0.0	0.0
Main big city	11.0	14.0	9.4	12.0	8.3	10.9	11.1	17.2	8.9	22.5	9.6	11.1	10.3	9.9	12.5	0.0	0.0	0.0	100.0	0.0	0.0	0.0
Urban fringe	13.2	14.3	5.6	19.1	12.9	13.1	13.3	3.6	15.3	9.1	7.5	10.7	12.9	14.3	13.6	0.0	0.0	0.0	0.0	100.0	0.0	0.0
Medium city	13.2	7.8	21.4	10.1	14.4	13.2	13.2	12.6	13.9	6.3	11.8	10.4	11.9	14.9	15.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0
Small places	33.0	28.1	41.3	28.2	35.4	33.6	32.3	17.7	36.3	26.5	38.2	40.4	36.7	29.5	32.2	0.0	0.0	0.0	0.0	0.0	0.0	100.0

TABLE C-3. Estimated Population Distributions of Reporting Groups: Science, 1969-70, Age 13

	Nat'l (%)	Region				Sex		Race			Parental Education					Size and Type of Community						
		NE	SE	C	W	M	F	B	WH	OTH	NHS	SHS	GHS	PHS	UNK	ER	LM	HM	MBC	UF	MC	SP
Region																						
Northeast	26.1	100.0	0.0	0.0	0.0	26.6	25.5	18.4	28.0	17.2	15.9	19.3	27.6	26.3	31.4	5.1	33.1	33.2	19.0	33.8	21.9	28.7
Southeast	20.9	0.0	100.0	0.0	0.0	20.0	21.6	45.0	18.0	6.7	37.1	36.3	20.7	16.2	20.4	33.6	18.4	7.0	18.4	8.5	25.2	26.2
Central	28.7	0.0	0.0	100.0	0.0	29.1	28.4	20.9	31.3	12.1	21.9	23.2	32.3	29.9	19.8	34.5	31.5	20.4	26.4	29.2	26.2	31.3
West	24.4	0.0	0.0	0.0	100.0	24.4	24.5	15.7	22.8	64.0	25.1	21.2	19.4	27.5	28.4	26.8	17.0	39.4	36.2	28.6	26.8	13.8
Sex																						
Male	48.9	49.9	47.0	49.5	48.8	100.0	0.0	47.2	49.0	51.1	46.9	46.4	49.1	49.1	50.8	48.2	47.4	47.4	48.4	50.7	48.7	49.6
Female	51.1	50.1	53.0	50.5	51.2	0.0	100.0	52.8	51.0	48.9	53.1	53.6	50.9	50.9	49.3	51.8	52.6	52.6	51.6	49.3	51.3	50.4
Race																						
Black	13.3	9.4	28.8	9.7	8.6	12.8	13.7	100.0	0.0	0.0	18.8	18.1	13.4	9.4	24.7	22.1	57.0	4.8	14.2	8.9	10.5	6.4
White	80.5	86.6	69.3	87.7	75.3	80.8	80.4	0.0	100.0	0.0	59.2	72.4	82.1	86.6	64.5	65.0	25.6	89.8	77.7	87.1	86.1	90.2
Other	6.1	4.0	2.0	2.6	16.1	6.4	5.8	0.0	0.0	100.0	22.0	9.5	4.6	4.0	10.8	12.9	17.4	5.5	8.1	3.9	3.4	3.4
Parental education																						
No high school	4.2	2.6	7.5	3.2	4.4	4.1	4.4	6.0	3.1	15.2	100.0	0.0	0.0	0.0	0.0	9.2	5.7	1.2	3.3	1.7	3.8	5.1
Some high school	9.7	7.2	16.9	7.9	8.5	9.2	10.2	13.2	8.8	15.1	0.0	100.0	0.0	0.0	0.0	16.9	11.6	2.1	9.1	6.3	9.4	11.7
Graduated high school	31.4	33.2	31.2	35.2	25.0	31.5	31.2	31.5	32.0	23.4	0.0	0.0	100.0	0.0	0.0	33.5	29.5	19.0	31.6	32.7	30.0	35.5
Post high school	45.3	45.7	35.2	47.2	51.2	45.5	45.1	31.9	48.6	29.8	0.0	0.0	0.0	100.0	0.0	35.1	27.7	67.2	41.3	48.9	50.2	42.2
Unknown	9.4	11.4	9.2	6.5	11.0	9.8	9.1	17.5	7.6	16.6	0.0	0.0	0.0	0.0	100.0	5.3	25.5	10.5	14.7	10.4	6.7	5.4
Size and type of Community																						
Extreme rural	8.0	1.6	12.9	9.6	8.8	7.9	8.1	13.2	6.5	16.8	17.3	13.9	8.5	6.2	4.5	100.0	0.0	0.0	0.0	0.0	0.0	0.0
Low metro	7.9	10.1	7.0	8.7	5.6	7.6	8.1	34.0	2.5	22.6	10.7	9.5	7.5	4.9	21.5	0.0	100.0	0.0	0.0	0.0	0.0	0.0
High metro	11.3	14.4	3.8	8.0	18.2	10.9	11.6	4.0	12.5	10.0	3.3	2.4	6.8	16.7	12.5	0.0	0.0	100.0	0.0	0.0	0.0	0.0
Main big city	11.6	8.5	10.2	10.7	17.2	11.5	11.7	12.4	11.2	15.4	9.1	10.9	11.7	10.6	18.8	0.0	0.0	0.0	100.0	0.0	0.0	0.0
Urban fringe	11.7	15.1	4.8	11.9	13.7	12.1	11.3	7.8	12.6	7.5	4.6	7.6	12.2	12.6	12.9	0.0	0.0	0.0	0.0	100.0	0.0	0.0
Medium city	15.9	13.3	19.2	14.5	17.5	15.9	16.0	12.6	17.0	8.9	14.4	15.3	15.2	17.7	11.2	0.0	0.0	0.0	0.0	0.0	100.0	0.0
Small places	33.7	37.1	42.2	36.7	19.1	34.1	33.2	16.0	37.7	18.9	40.6	40.6	38.1	31.4	19.3	0.0	0.0	0.0	0.0	0.0	0.0	100.0

TABLE C-4. Estimated Population Distributions of Reporting Groups: Science, 1972-73, Age 13

	Nat'l (%)	Region				Sex		Race			Parental Education					Size and Type of Community						
		NE	SE	C	W	M	F	B	WH	OTH	NHS	SHS	GHS	PHS	UNK	ER	LM	HM	MBC	UF	MC	SP
Region																						
Northeast	24.4	100.0	0.0	0.0	0.0	23.7	25.1	20.7	25.9	13.0	13.0	19.6	25.7	26.7	23.5	0.6	25.0	47.7	30.4	35.7	15.9	20.1
Southeast	22.5	0.0	100.0	0.0	0.0	22.3	22.7	41.4	21.0	4.0	36.9	35.4	20.5	18.5	23.5	30.9	11.5	3.4	13.1	1.9	36.0	35.8
Central	28.2	0.0	0.0	100.0	0.0	29.2	27.2	23.8	30.4	9.6	21.4	22.8	31.3	28.3	27.6	47.1	25.4	33.9	38.1	27.5	21.0	20.6
West	25.0	0.0	0.0	0.0	100.0	24.9	25.0	14.2	22.7	73.4	28.8	22.2	22.5	26.6	25.4	21.4	38.1	14.9	18.5	35.0	27.1	23.5
Sex																						
Male	50.0	48.6	49.6	51.8	49.9	100.0	0.0	48.4	50.4	48.2	48.8	43.4	50.2	50.6	52.4	52.5	49.0	48.9	48.2	51.2	49.8	50.0
Female	50.0	51.5	50.4	48.2	50.2	0.0	100.0	51.6	49.6	51.8	51.2	56.6	49.8	49.4	47.6	47.5	51.0	51.1	51.8	48.8	50.2	50.0
Race																						
Black	12.6	10.7	23.3	10.6	7.2	12.2	13.0	100.0	0.0	0.0	15.5	19.8	11.7	7.6	23.1	9.9	45.8	1.8	22.6	6.9	13.[illegible]	8.8
White	80.7	85.8	75.5	87.1	73.3	81.4	80.1	0.0	100.0	0.0	62.0	72.2	83.6	89.2	64.8	79.6	32.7	94.8	66.8	88.1	82.4	87.2
Other	6.6	3.5	1.2	2.2	19.5	6.4	6.9	0.0	0.0	100.0	22.6	8.0	4.6	3.2	12.2	10.5	21.6	3.4	10.7	5.0	3.1	4.0
Parental education																						
No high school	6.7	3.6	10.9	5.1	7.7	6.5	6.8	8.1	5.1	22.7	100.0	0.0	0.0	0.0	0.0	14.1	7.9	1.4	6.1	3.6	4.8	8.3
Some high school	8.2	6.5	12.9	6.6	7.3	7.1	9.2	12.8	7.3	9.9	0.0	100.0	0.0	0.0	0.0	10.0	11.1	3.2	6.8	7.0	6.6	10.4
Graduated high school	30.1	31.6	27.5	33.4	27.1	30.2	30.0	27.9	31.2	21.0	0.0	0.0	100.0	0.0	0.0	33.1	28.8	21.2	28.8	34.2	26.3	32.8
Post high school	40.4	44.1	33.3	40.5	43.0	40.9	39.9	24.3	44.6	19.4	0.0	0.0	0.0	100.0	0.0	28.9	22.5	64.8	38.3	42.4	48.7	35.5
Unknown	14.7	14.2	15.4	14.4	15.0	15.4	14.0	26.9	11.8	27.1	0.0	0.0	0.0	0.0	100.0	14.0	29.8	9.4	20.0	12.8	13.6	13.1
Size and type of Community																						
Extreme rural	10.3	0.3	14.2	17.3	8.8	10.8	9.8	8.1	10.2	16.4	21.9	12.6	11.4	7.4	9.8	100.0	0.0	0.0	0.0	0.0	0.0	0.0
Low metro	7.2	7.4	3.7	6.5	11.0	7.1	7.3	26.1	2.9	23.4	8.6	9.8	6.9	4.0	14.5	0.0	100.0	0.0	0.0	0.0	0.0	0.0
High metro	11.5	22.6	1.8	13.9	6.9	11.3	11.8	1.7	13.5	6.0	2.5	4.6	8.1	18.5	7.3	0.0	0.0	100.0	0.0	0.0	0.0	0.0
Main big city	11.0	13.6	6.4	14.8	8.1	10.6	11.4	19.6	9.1	17.6	10.0	9.2	10.5	10.4	14.9	0.0	0.0	0.0	100.0	0.0	0.0	0.0
Urban fringe	14.4	21.0	1.2	14.0	20.2	14.8	14.1	7.9	15.7	10.8	7.7	12.3	16.4	15.1	12.5	0.0	0.0	0.0	0.0	100.0	0.0	0.0
Medium city	13.8	9.0	22.1	10.2	14.9	13.7	13.8	14.7	14.2	6.5	9.8	11.1	12.0	16.6	12.7	0.0	0.0	0.0	0.0	0.0	100.0	0.0
Small places	31.9	26.2	50.8	23.3	30.1	31.9	31.9	22.1	34.4	19.3	39.5	40.4	34.8	28.0	28.2	0.0	0.0	0.0	0.0	0.0	0.0	100.0

TABLE C-5. Estimated Population Distributions of Reporting Groups: Science, 1969-70, Age 17

	Nat'l (%)	Region				Sex		Race			Parental Education					Size and Type of Community					
		NE	SE	C	W	M	F	B	WH	OTH	NHS	SHS	GHS	PHS	UNK	ER	LM	HM	MBC	UF	MC	SP
Region																						
Northeast	23.3	100.0	0.0	0.0	0.0	25.2	25.4	22.0	26.0	19.4	17.6	23.9	27.0	25.8	12.4	2.8	35.3	30.3	23.4	29.2	18.5	31.0
Southeast	17.2	0.0	100.0	0.0	0.0	16.9	17.6	36.6	15.9	3.4	33.2	23.9	15.6	14.7	11.6	44.3	7.9	17.0	16.6	0.0	23.3	14.4
Central	32.1	0.0	0.0	100.0	0.0	31.6	32.5	22.6	33.3	30.0	27.6	34.0	36.0	29.5	22.2	30.6	17.1	16.0	38.4	24.0	32.4	40.4
West	25.4	0.0	0.0	0.0	100.0	26.3	24.5	18.8	24.8	47.3	21.6	18.2	21.3	29.9	53.9	22.2	39.7	36.8	21.7	46.8	25.8	14.2
Sex																						
Male	48.5	48.2	47.5	47.8	50.2	100.0	0.0	43.8	49.0	48.5	46.7	45.8	49.4	48.5	57.2	46.6	45.3	52.2	45.3	49.8	50.3	48.0
Female	51.6	51.8	52.5	52.2	49.8	0.0	100.0	56.2	51.0	51.5	53.3	54.2	50.6	51.6	42.9	51.4	54.7	47.8	54.7	50.2	49.7	52.0
Race																						
Black	9.6	8.4	20.4	6.8	7.1	8.7	10.5	100.0	0.0	0.0	20.3	16.7	10.6	5.3	15.2	19.0	45.1	3.5	10.1	2.9	7.5	3.7
White	85.3	87.7	78.6	88.4	83.3	86.2	84.4	0.0	100.0	0.0	68.7	77.0	84.6	90.5	74.7	73.0	42.4	91.3	83.3	94.2	91.4	91.4
Other	5.1	3.9	1.0	4.8	9.6	5.1	5.1	0.0	0.0	100.0	11.0	6.3	4.8	4.2	10.1	8.0	12.5	5.2	6.5	2.8	1.1	4.9
Parental education																						
No high school	5.1	3.6	9.9	4.4	4.4	4.9	5.3	10.8	4.1	11.0	100.0	0.0	0.0	0.0	0.0	12.8	7.8	1.6	4.7	2.3	4.1	5.0
Some high school	14.3	13.5	19.8	15.1	10.3	13.5	15.0	24.9	12.9	17.6	0.0	100.0	0.0	0.0	0.0	20.4	19.9	5.1	14.7	10.8	12.0	16.0
Graduated high school	33.0	35.2	29.9	37.0	27.7	33.6	32.3	36.4	32.7	30.8	0.0	0.0	100.0	0.0	0.0	32.5	35.6	20.5	34.0	32.8	32.2	36.2
Post high school	46.0	46.9	39.3	42.4	54.2	46.0	46.0	25.4	48.9	37.4	0.0	0.0	0.0	100.0	0.0	33.2	30.9	70.4	45.4	52.3	50.5	42.0
Unknown	1.6	0.8	1.1	1.1	3.4	1.9	1.3	2.6	1.4	3.2	0.0	0.0	0.0	0.0	100.0	1.1	5.7	2.4	1.2	1.8	1.3	0.9
Size and type of Community																						
Extreme rural	9.4	1.0	24.1	8.9	8.2	9.4	9.3	18.5	8.0	14.6	23.4	13.4	9.2	6.8	6.2	100.0	0.0	0.0	0.0	0.0	0.0	0.0
Low metro	7.4	10.3	3.4	3.9	11.5	6.9	7.8	34.6	3.7	18.0	11.3	13.3	8.0	5.0	26.2	0.0	100.0	0.0	0.0	0.0	0.0	0.0
High metro	9.5	11.3	9.3	4.7	13.7	10.2	8.8	3.5	10.1	9.6	3.0	3.4	5.9	14.5	14.1	0.0	0.0	100.0	0.0	0.0	0.0	0.0
Main big city	13.5	12.5	13.0	16.1	11.5	12.6	14.3	14.3	13.2	17.2	12.5	13.9	13.9	13.3	9.8	0.0	0.0	0.0	100.0	0.0	0.0	0.0
Urban fringe	10.6	12.3	0.0	8.0	19.6	10.9	10.4	3.3	11.8	5.9	4.8	8.0	10.6	12.1	12.2	0.0	0.0	0.0	0.0	100.0	0.0	0.0
Medium city	16.8	12.2	22.7	16.9	17.1	17.4	16.2	13.1	18.0	3.6	13.2	14.1	16.4	18.4	13.4	0.0	0.0	0.0	0.0	0.0	100.0	0.0
Small places	32.9	40.4	27.6	41.4	18.4	32.6	33.2	12.8	35.3	31.2	31.9	36.9	36.1	30.0	18.1	0.0	0.0	0.0	0.0	0.0	0.0	100.0

TABLE C-6. Estimated Population Distributions of Reporting Groups: Science, 1972-73, Age 17

	Nat'l (%)	Region				Sex		Race			Parental Education					Size and Type of Community						
		NE	SE	C	W	M	F	B	WH	OTH	NHS	SHS	GHS	PHS	UNK	ER	LM	HM	MBC	UF	MC	SP
Region																						
Northeast	26.6	100.0	0.0	0.0	0.0	25.7	27.4	16.8	28.8	14.1	17.0	22.1	27.7	26.4	40.7	0.5	31.8	42.1	24.3	38.1	15.9	25.8
Southeast	20.5	0.0	100.0	0.0	0.0	20.3	20.8	40.4	18.4	9.6	31.4	29.9	18.7	17.9	21.1	34.3	9.7	7.3	16.9	8.7	24.5	29.1
Central	28.8	0.0	0.0	100.0	0.0	28.9	28.7	26.6	30.4	9.7	23.7	27.7	34.9	27.1	18.9	45.3	32.4	24.2	50.3	23.0	25.6	24.1
West	24.1	0.0	0.0	0.0	100.0	25.1	23.2	16.2	22.4	66.7	27.9	20.4	18.8	28.7	19.3	19.9	26.1	26.4	8.5	30.3	34.1	21.0
Sex																						
Male	48.3	46.8	47.7	48.5	50.3	100.0	0.0	44.3	49.0	46.6	44.5	44.5	49.1	48.9	50.3	49.7	46.7	46.3	44.7	45.8	50.5	50.2
Female	51.7	53.2	52.3	51.5	49.7	0.0	100.0	55.7	51.0	53.4	55.5	55.5	50.9	51.1	49.7	50.3	53.3	53.7	55.3	54.2	49.5	49.8
Race																						
Black	12.0	7.6	23.6	11.1	8.1	11.0	12.9	100.0	0.0	0.0	18.9	21.9	11.3	6.8	29.8	12.3	44.9	2.6	26.4	4.1	11.9	7.2
White	82.5	89.5	73.8	87.1	76.7	83.7	81.4	0.0	100.0	0.0	58.4	71.2	85.4	90.5	54.0	78.8	39.0	95.6	62.8	90.0	86.1	89.6
Other	5.5	2.9	2.6	1.9	15.2	5.3	5.7	0.0	0.0	100.0	22.7	6.8	3.3	2.7	16.2	8.9	16.1	1.8	10.8	5.9	2.1	3.2
Parental education																						
No high school	6.8	4.4	10.5	5.6	7.9	6.3	7.4	10.8	4.8	28.2	100.0	0.0	0.0	0.0	0.0	16.0	9.8	1.5	4.6	3.9	4.5	8.5
Some high school	10.3	8.6	15.0	9.9	8.7	9.5	11.1	18.9	8.9	12.8	0.0	100.0	0.0	0.0	0.0	13.7	15.0	3.7	11.1	9.4	8.8	11.5
Graduated high school	30.8	32.1	28.1	37.3	24.0	31.3	30.3	29.0	31.9	18.5	0.0	0.0	100.0	0.0	0.0	36.0	32.0	21.7	30.4	33.0	29.9	31.9
Post high school	45.9	45.5	40.1	43.1	54.5	46.5	45.3	26.1	50.3	22.3	0.0	0.0	0.0	100.0	0.0	29.6	28.3	71.1	35.7	49.5	53.3	43.3
Unknown	6.2	9.5	6.3	4.1	4.9	6.4	5.9	15.3	4.0	18.2	0.0	0.0	0.0	0.0	100.0	4.7	15.0	2.0	18.3	4.3	3.6	4.8
Size and type of Community																						
Extreme rural	8.6	0.2	14.4	13.5	7.1	8.9	8.4	8.8	8.2	14.0	20.1	11.4	10.1	5.6	6.5	100.0	0.0	0.0	0.0	0.0	0.0	0.0
Low metro	8.5	10.2	4.0	9.6	9.2	8.2	8.8	31.9	4.0	25.0	12.2	12.4	8.9	5.3	20.7	0.0	100.0	0.0	0.0	0.0	0.0	0.0
High metro	12.1	19.3	4.3	10.2	13.3	11.6	12.6	2.6	14.1	4.0	2.7	4.3	8.5	18.8	4.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0
Main big city	8.1	7.4	6.7	14.2	2.9	7.5	8.7	17.9	6.2	15.9	5.4	8.7	8.0	6.3	24.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0
Urban fringe	15.3	21.9	6.4	12.2	19.2	14.5	16.0	5.3	16.7	16.2	8.6	13.9	16.3	16.5	10.5	0.0	0.0	0.0	0.0	100.0	0.0	0.0
Medium city	13.0	7.8	15.6	11.6	18.4	13.6	12.5	12.9	13.6	4.9	8.5	11.1	12.6	15.2	7.6	0.0	0.0	0.0	0.0	0.0	100.0	0.0
Small places	34.3	33.3	48.6	28.7	29.9	35.6	33.1	20.7	37.2	20.0	42.4	38.2	35.6	32.4	26.7	0.0	0.0	0.0	0.0	0.0	0.0	100.0

APPENDIX D

TABLES OF RESPONSE PATTERNS

TABLE D-1. Mean Percentages for Correct, "I Don't Know" and Other Responses for Selected Categories of Respondents, Age 9

Category	Response	Mean % 1970	Mean % 1973	Mean Change*
National	Correct	61.1	59.4	-1.7
	IDK**	6.2	6.0	-0.2
	Other	32.7	34.6	1.9
Northeast	Correct	63.4	61.3	-2.2
	IDK	6.0	5.4	-0.5
	Other	30.6	33.3	2.7
Southeast	Correct	55.8	55.4	-0.4
	IDK	6.2	6.8	0.6
	Other	38.0	37.8	-0.2
Central	Correct	62.6	60.8	-1.8
	IDK	6.1	5.6	-0.5
	Other	31.3	33.6	2.3
West	Correct	61.4	60.0	-1.4
	IDK	6.5	6.1	-0.4
	Other	32.1	33.9	1.8
Boys	Correct	62.2	60.5	-1.6
	IDK	5.2	5.1	-0.1
	Other	32.6	34.4	1.8
Girls	Correct	60.0	58.4	-1.7
	IDK	7.2	6.8	-0.4
	Other	32.8	34.8	2.0
Whites	Correct	64.1	62.6	-1.5
	IDK	5.9	5.6	-0.2
	Other	30.0	31.8	1.8
Blacks	Correct	47.0	46.1	-0.9
	IDK	7.4	7.1	-0.3
	Other	45.6	46.8	1.2
Extreme rural	Correct	55.3	56.5	1.2
	IDK	6.7	6.5	-0.3
	Other	38.0	37.0	-1.0
Low metro	Correct	46.2	46.0	-0.2
	IDK	7.7	7.6	-0.1
	Other	46.1	46.4	0.3
High metro	Correct	69.2	66.5	-2.7
	IDK	4.4	4.7	0.3
	Other	26.4	28.8	2.4

**The mean change is the mean of the changes and may differ here from the differences in the means because of rounding.*

***IDK refers to the "I don't know" response.*

TABLE D-2. Mean Percentages for Correct, "I Don't Know" and Other Responses for Selected Categories of Respondents, Age 13

Category	Response	Mean % 1969	Mean % 1972	Mean Change*
National	Correct	60.2	58.3	-1.9
	IDK**	6.9	8.1	1.1
	Other	32.9	33.6	0.7
Northeast	Correct	62.0	60.7	-1.3
	IDK	6.5	7.8	1.2
	Other	31.5	31.5	0.0
Southeast	Correct	55.1	55.4	0.3
	IDK	6.1	7.3	1.2
	Other	38.8	37.3	-1.5
Central	Correct	62.6	59.9	-2.8
	IDK	6.9	8.5	1.7
	Other	30.5	31.6	1.1
West	Correct	59.8	56.9	-2.9
	IDK	8.1	8.5	0.4
	Other	32.1	34.6	2.5
Boys	Correct	62.3	60.5	-1.9
	IDK	6.1	7.1	1.0
	Other	31.6	32.4	0.8
Girls	Correct	58.2	56.2	-2.0
	IDK	7.7	9.0	1.3
	Other	34.1	34.8	0.7
Whites	Correct	63.5	61.8	-1.7
	IDK	6.6	7.6	1.0
	Other	29.9	30.6	0.7
Blacks	Correct	44.9	41.7	-3.2
	IDK	7.9	9.9	2.0
	Other	47.2	48.4	1.2
Extreme rural	Correct	54.0	56.2	2.2
	IDK	8.3	7.5	-0.8
	Other	37.7	36.3	-1.4
Low metro	Correct	47.2	44.9	-2.3
	IDK	8.8	10.4	1.6
	Other	44.0	44.7	0.7
High metro	Correct	66.6	65.4	-1.2
	IDK	6.6	8.0	1.4
	Other	26.8	26.6	-0.2

**The mean change is the mean of the changes and may differ here from the difference in the means because of rounding.*

***IDK refers to the "I don't know" response.*

TABLE D-3. Mean Percentages for Correct, "I Don't Know" and Other Responses for Selected Categories of Respondents, Age 17

Category	Response	Mean % 1969	Mean % 1973	Mean Change*
National	Correct	45.6	42.3	-3.2
	IDK**	12.9	14.0	1.1
	Other	41.5	43.7	2.2
Northeast	Correct	47.9	44.4	-3.5
	IDK	12.1	13.5	1.4
	Other	40.0	42.1	2.1
Southeast	Correct	42.4	40.8	-1.6
	IDK	12.0	13.3	1.3
	Other	45.6	45.9	0.3
Central	Correct	45.5	42.5	-3.0
	IDK	13.7	14.3	0.6
	Other	40.8	43.2	2.4
West	Correct	45.6	41.1	-4.5
	IDK	13.2	14.6	1.4
	Other	41.2	44.3	3.1
Boys	Correct	48.8	45.3	-3.4
	IDK	11.3	12.2	0.9
	Other	39.9	42.5	2.6
Girls	Correct	42.6	39.6	-3.0
	IDK	14.4	15.6	1.2
	Other	43.0	44.8	1.8
Whites	Correct	47.2	44.5	-2.7
	IDK	12.9	13.6	0.7
	Other	39.9	41.9	2.0
Blacks	Correct	33.9	32.0	-1.9
	IDK	12.3	15.3	2.9
	Other	53.8	52.7	-1.1
Extreme rural	Correct	41.7	40.7	-1.0
	IDK	12.6	14.4	1.8
	Other	45.7	44.9	-0.8
Low metro	Correct	38.6	34.2	-4.5
	IDK	12.8	15.5	2.7
	Other	48.6	50.3	1.7
High metro	Correct	50.9	46.9	-4.1
	IDK	12.6	13.2	0.6
	Other	36.5	39.9	3.4

**The mean change is the mean of the changes and may differ here from the differences in the means because of rounding.*

***IDK refers to the "I don't know" response.*

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